NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS

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Sustainable development

Foundations of the sustainability concept

Genesis and evolution of the sustainability concept has been described in brief. From classical writings of Adam Smith to the most important contributions of the twentieth century economic theory, have been analyzed in order to present the foundations of modern sustainability concept. A period from the end of the Second World War to the mid seventies, characterized by high economic growth rates, can be described as the age of pan-technological optimism. The end of this age, which came in the face of petrol shocks, opened a broad area for new studies in theory of natural resource use and environmental economics. Creation of the international institutions dealing with the environmental issues is analyzed. Numerous activities of governmental and nongovernmental organizations, from 1972 Stockholm Conference to UN Conference of Environment and Development held in Rio de Janeiro 1992, are mentioned. At the end of this chapter three various sets of rationales for sustainable development are analyzed. Moral reasons, based on theory of justice, given by John Rawls, environmental reasons and economic reasons are briefly put forward.

Sustainable development and the Laws of Thermodynamics.

The basis of this chapter in given in a book *The Entropy Law and Economic Process* by Nicholas Georgescu-Roegen. Studies of the several Georgescu-Roegen's predecessors are mentioned, among them Kosta Stojanovic, a prominent Serbian scholar from the beginning of the twentieth century.

Definitions and meanings of sustainability

Different concepts of sustainability that are apparent in modern literature have been classified in to five groups. Attempts to give the most adequate definition of a sustainable development are analyzed. From early writings of Robert Solow to the most recent contributions of Common and Perrings are presented in a concise manner.

Economics of renewable resources

Theory of optimal resource use

Classification of economic resources is given. Characteristics of renewable natural resources are explained Static analysis deals with biological essence of the renewable resources. Natural growth rates of biological populations, and the level of harvesting effort, are analyzed simultaneously in order to define the optimal harvest. This part is based on the approach of Pearce and Turner (Pearce, D.W. and Turner K.R. 1990 *Economics of Natural Resources and the Environment.* New York, Harvester Wheatsheaf.) By introducing various cost functions, an analytical framework for profit maximization is created. Profit maximization from renewable resources is explored under the different property regimes. Difference between the optimal effort level in open access, collective ownership and private property has been demonstrated. Static equilibrium under the private property regime is analyzed from an individual and from public cost aspect. Dynamic analysis is based on an introduction of time dimension. A solution of profit maximizing equation in infinite time horizon reveals the optimal exploitation rule, which is an alternative form of Hotelling rule.

Renewable resource harvesting policy

All the environmental policy instruments aimed to protect renewable resources are classified in to three groups: legal instruments, quantitative restrictions and economic instruments. The essence of legal instruments can be found in establishing of an adequate property rights structure. The limitation of open access regime is most common legal step in conservation and restoration policies. Quantitative restrictions can be implemented either as effort restrictions or as harvest restrictions. However, those restrictions are inefficient, not only because of the ex post character, but because they are hard to be implemented and costly to be monitored. Economic instruments, owing to the market orientation, are much more efficient. Among them fiscal instruments (taxes and subsidies) are analyzed in comparison with the individual transferable quota (ITQ) systems. All the aspects of ITQ are broadly discussed, based on the experiences from New Zealand, Canada, USA and Australia .

Economics of non-renewable resources

Theory of optimal resource extraction

This part is also based on the theoretical approach given by Pearce and Turner, but combined with contributions of Perman, Ma and McGilvray (Perman, R. , Ma

Y. and McGilvray J. 1996 *Natural Resource & Environmental Economic.* London and New York, Longman.)
Starting from the Hotelling rule presentation, four-quadrant analytical framework has been used in order to explain the depletion of natural capital. By using the same framework, the influence of several parameters has been explored in the time dimension. Among them are: changing demand for exhaustible resources, changes in the backstop technology price, a change in the resource extraction costs, an increase in the size of the known resource stock, and changes in the discount rate.
Non-renewable resource use is analyzed, under different market conditions. Various models, from the optimal resource extraction in perfectly competitive markets, to the optimal extraction in monopoly conditions, are analyzed in details. The issue of natural resource scarcity has also been broadly discussed. Several different approaches, aimed to clarify the scarcity controversy, are described. A broad range of views, from seminal paper of Barnett and Morse (Barnett, H.J. and Morse, C. 1963 *The Scarcity and Growth:The Economics of Natural Resource Availability.* Baltimore MD, Johns Hopkins University Press.) to Hartwick's and Olewiler's findings (Hartwick, J. M. and Olewiler, N.D. 1986 *The Economics of Natural Resource Use.* New York, Harper and Row.) Are discussed.

Non-renewable resource use policy

Economic instruments, alongside with various recycling and substitution practices are analyzed, in different market conditions. A significant attention has been paid to taxes and subsidies and their effects on resource extraction. A simple equilibrium model is used to demonstrate a limited potential of recycling practices in the modern world. At the end Hartwick rule is presented in the context of sustainable development claims.

The economics of pollution

Classification of the pollution forms

Started with an analysis of physical and economic meanings of the pollution, several classifications of pollution forms are given at the beginning of the chapter.

The efficient pollution level determination

The efficient level of pollution is presented according to Perman, Ma and McGilvray. The efficient level of flow pollution is determined by using dynamic

optimization method. By using the same mathematical tool, stock pollution is discussed separately for perfectly persistent and imperfectly persistent stock pollutants.

Pollution control policies

Pollution control policy is explained from the economically efficient pollution abetment aspect. Various policies for direct and indirect control have been examined. Quantitative control practices are analyzed from OECD countries' experiences. Market based instruments, including fiscal instruments and transferable emissions permits, are broadly analyzed. Special emphasis is given to the US experience in Sulfur Dioxide emissions trading. However, the potential limitations of this instrument are also discussed, especially for dealing with mobile pollutant sources.

Macroeconomic accounting of environment and natural resource use

The chapter starts with an introductory story about genesis and evolution of the System of National Accounts (SNA) created by the United Nations Statistical Office. The story is based mostly on numerous OUN publications. An attempt to integrate economic and environmental accounts is broadly discussed from the World Bank publications viewpoint (Ahmad, Y.J. , El Serafy, S. and Lutz, E. eds. *Environmental Accounting for Sustainable Development.* Washington D.C. ,The World Bank). The User Cost Method, created by El Serafy, got a central role in the chapter. A satellite system for integrated environmental and economic accounting, published in 1993, is extensively described. The chapter is completed by a presentation of the latest version of System of Environmental Economic Accounts (SEEA).