ECON 455 : Environmental Economic Theory

Instructor: Andy Yates
Textbooks: 1. *Environmental Economics*, by Charles D. Kolstad
2. Comprehensive class notes, by Andy Yates
Prerequisite: ECON 410

CATALOG DESCRIPTION

A rigorous economic analysis of environmental issues, with particular emphasis on the problem of designing appropriate institutions and regulations under private information and the interaction between economic and ecological systems. Topics include emission fees and marketable permits, pollution models, carbon regulation, and ecosystem service markets.

COURSE GOALS and OBJECTIVES

1. The primary goal is to apply economic theory to understand the principles of environmental protection.

2. The secondary goal is to help students make connections between economics and ecology.

COURSE RATIONALE AND CONTENT DESCRIPTION

In this class we progressively analyze increasingly complex interactions between economic and ecological systems.

We start with a basic review of calculus, optimization and economics. At a very general level, any economic activity is quantified by the benefits and costs that accrue to that activity. Efficiency requires that the difference between benefits and costs be maximized, and by using calculus we can characterize efficiency with the simple rule that marginal benefits should be equal to marginal costs. We illustrate this rule for several classic economic models from producer and consumer theory. This serves as a review of material that students learned in Economics 410 as well as a foundation for further analysis.

The interactions between economics and ecology analyzed in the course can be characterized by three conceptual levels. In the first level, the ecological system acts as simple repository for the residuals from production. Economic considerations consist of two primary functions. The abatement cost function specifies the costs to firms of reducing pollution. The damage function specifies the harmful ecological effects of the pollution. Using calculus, the efficient quantity of pollution is shown to be the point at which the marginal abatement costs are equal to marginal damages.

There are three broad categories of regulations designed to ameliorate the damages from pollution. These are standards, taxes, and permits. With standards, the regulator requires all firms to undertake some prescribed action. For example, coal fired electric power plants may be required to install scrubbers to reduce S02 emission. With taxes, firms are required to pay a fixed

fee for every unit of pollution emitted. With permits, the regulator creates a fixed number of permits to emit pollution, and these permits trade in a market.

We give a complete characterization of each of the three categories of regulations. Permits in particular have a rich set of associated issues, as firms may attempt to manipulate the market price to their advantage, groups of citizens may want to participate directly in the permit market to reduce the level of pollution, and both firms and citizens may lobby regulators for a more favorable allocation of permits.

We conclude the analysis of the first level by introducing the important issue of private information. It is quite likely that firms have better information about their abatement costs than the regulator that must design the regulation. This complication requires a brief review of yet another mathematical concept, that of a random variable.

Using the model with private information, we analyze the performance of the three categories of regulations. We show that permits and taxes are generally superior to standards, but the comparison between permits and taxes is ambiguous. In certain cases taxes perform better, but in other cases permits perform better. The model with private information also serves as a starting point for a brief introduction to an important area of economics called mechanism design. In a mechanism, the regulator asks the firms to provide information about their costs. The regulator uses a set of previously determined rules to convert these reports into a policy. The goal is to set up the rules in such a manner that the firms have the incentive to tell the truth about their costs. We analyze several mechanisms and discuss conditions under which the goal of truth telling is obtained.

In the second conceptual level, we consider richer models of the ecological system. Here the damages from pollutions may have a spatial or temporal component. We consider modifications to the basic regulations discussed earlier to account for these effects. Particular emphasis is given to the design of permit markets, where we consider both trading ratios and zones. In a market with trading ratios, emissions between firms do not trade on a one-for-one basis, but rather are governed by the trading ratios. In other words, firms may have to buy more or less than one permit to emit one unit of pollution. In a market with zones, not all firms are allowed to trade with each other. Rather, the market in broken up into a system of zones, and firms in a given zone are allowed to trade permits, but firms may not trade permits across the zones.

A detailed example of carbon regulation is used to conclude the second conceptual level. We discuss a model of dynamic carbon accumulation in the atmosphere and characterize the optimal rate of carbon emissions. We also give a detailed analysis of the incentives facing the various countries in the European Union Carbon Emissions Trading System.

In the third conceptual level, we consider the most complex interactions between economic and ecological systems. This is accomplished through the study of no-net-loss regulation of ecosystem service markets. We link an economic model of free-entry equilibria with an ecological model that includes returns to scale and inefficiency of restored ecosystems. We show that intuition from ecology alone must be modified to account for economic processes, and vice versa. For example, to implement no-net-loss regulation, one must not only account for

ecological differences between restored and natural ecosystems, but also consider the effect of market entry on the number and size of restoration projects. In a purely economic model, free-entry equilibria are characterized by excess entry: the equilibrium number of firms is greater than the welfare maximizing number. Ecological considerations may exacerbate or ameliorate this, so that either excess entry or insufficient entry may occur, depending on the specific ecosystem services sought.

COURSE REQUIREMENTS

There are two mid-term exams, one final exam, and six homework assignments. Each exam counts for 30 percent of the grade and the homework in total counts for 10 percent of the grade. Exams are during class time. There are no make up exams. Homework is due at the beginning of class.

COURSE OUTLINE

Microeconomics Review (1 week)
1. Class notes Chapter 1
2. Kolstad, Chapter 3,4

Economics of Public Goods and Pollution (3 weeks)
1. Class notes Chapter 2,3
2. Kolstad Chapter 5

Standards, Taxes, Permits (3 weeks)
1. Class notes, Chapter 4
2. Kolstad Chapters 7,8,9

Private Information (3 weeks)
1. Class notes Chapter 5
2. Kolstad Chapter 10

Spatial and Temporal Models (2 weeks)
1. Class notes Chapter 6

Carbon Regulation (1 week)
1. Class notes Chapter 7

Ecosystem Service Markets (2 weeks)
1. Class notes Chapter 8