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METHODS

Ecological pricing and economic efficiency

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Abstract

There is a need to accurately account for the contributions of environmental assets to the overall economy. Such accounting would permit policies that allow protection of important natural resources and aid the analytic process to determine an accurate basis for a sustainable economy. The aim is to develop an accounting framework for ecology that is sufficiently consistent with the economic framework that the two can be fruitfully combined. With appropriate definitions of the flows, the two systems can be connected into a common framework. No single measure of the system productivity and efficiency can be given for the combined system, however, until the ecosystem metabolism can be converted into economic terms. This could be done with a series of economic valuation techniques. Ecological prices could then be estimated and a single measure of ecological economic output could be given. With the net combined system input and output now in common terms, a technical system efficiency measure can logically be proposed. Because human activity inevitably involves dissipation, such emissions would now have a monetary price. Because such emissions are irrecoverable, the total output of the combined system is greater than it is under the current definition, giving rise to a technical system-wide efficiency measure.

Keywords: Ecosystem; Economy; Prices; Input–output

1. Introduction

To achieve a sustainable economy, we must learn to value the economic contributions of all natural resources to the economy. This means that we must ultimately be specific about the value we place on every aspect of the environment external to the economy (Nordhaus, 2000). Matthews and Lave (2000) argue that to analyze the effectiveness of environmental programs and regulation and to improve environmental policy analysis requires the complex and controversial practice of evaluating the value of exchanges between nature and the economy. Bockstael et al. (2000) make the point that explicit valuation is a particularly human activity and, therefore, to measure the contributions of the environment

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around the economy, we must evaluate the unit exchanges of between them. These authors point the direction and lay out the goals for this paper. The input–output framework is chosen as the simplest, data-rich analytic process available for the early development of such an analysis.

Specialists in both economics and ecology extended the general analogous link between ecology and economics using input–output analysis through a series of papers. Hannon (1973) introduced input–output theory into ecology and applied it (Hannon and Joiris, 1987) to the North Sea ecosystem. The theoretical similarities of time value in the two systems also have been described (Hannon, 1990). More recently, a generalized ecological accounting framework was proposed (Hannon et al., 1991). But these efforts were dedicated mainly to demonstrating how ecological systems could be thought of in a parallel way with economic systems. Little attempt was made to combine the two systems into a single framework. The idea of the pricing of ecological flows in economic terms seemed insurmountable. The efforts of Costanza et al. (1997) to price the services rendered to the economy by the ecosystem have proven controversial and stirred up useful discussions (Arrow et al., 2000). The need for ecological pricing is the main focus of this paper. In addition, I have introduced the definition of a technical system efficiency measure.

The economist Winter (1964) described in great detail how a process like natural selection could be interpreted in understanding the behavior of the firm. Economists (Hirshleifer, 1978) also described the analogs of competitive behavior in biology and economic systems. Ecologists (Rapport and Turner, 1977) elaborated on consumer behavior and production analogies in natural communities. These authors stressed the nature of the analogues between the two fields.

The purpose is to combine the natural and economic processes in a common framework to make possible the formal rejoining of man and nature — of human activity and its environmental repercussions. This amalgam will allow the calculation of a set of economic prices for ecological goods and services.

The simplest method for combining these systems is the input–output accounting framework. In this framework, the analogy between the use of such a tool in both economics and ecology can be realized technically. The systems can be combined into a single matrix representation. Input–output systems provide a great deal of information for relatively small amounts of data collection and they force a balancing of inputs and outputs, thus eliminating under and multiple counting. With some additional data, I argue that the combined system can provide a means to calculate economic prices for ecological goods and services, and a measure for technical efficiency. However, the system is static, linear and requires a system equilibrium assumption. These requirements limit its usefulness. For my purposes here though, it supplies a reasonable tool to demonstrate how to calculate the economic value of ecosystem services. It is a useful point of beginning.

Ultimately, this analytic process cannot be completed without the conversion to monetary units of physical inputs to the economy from its external environment. This means that people must determine the unit values of such inputs and this requires evaluation techniques such as contingent valuation. While the process has considerable difficulties, particularly with the issue of aggregation of value, the field contains a large number of active researchers. Carson (2000) sums up the procedures, problems and status of the current research in the area.

2. The accounting framework for ecological and economic systems

A review of the current national accounting system used with slight variation throughout the industrial world is helpful. Here is a summary picture of that system.

The quest of this paper is to elaborate an analytical framework that can contain in a functional and meaningful way the economic and the ecological system. I begin with the accounting framework used for many years by economists, shown in Fig. 1, as a founding analogy.