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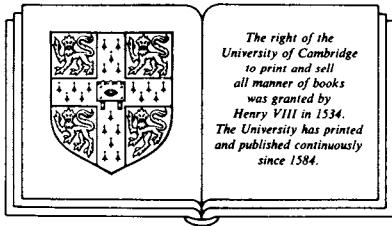
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# ECONOMY AND ENVIRONMENT

## A Theoretical Essay on the Interdependence of Economic and Environmental Systems

Charles Perrings

*University of Auckland*



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**TO ARISTIDES AND HARITINI, KIPARISSIA**

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## Preface

This book studies the dynamic implications of the links between the economy and its environment. In many disciplines, an examination of the relation between a referent system and the physical medium in which it exists – grows, stagnates, or contracts – would require no justification. In most anthropological models, for example, the environment is omnipresent. However, it is remarkable how unimportant the environment is in the eyes of most economists. The scarcity of resources, the *raison d'être* of the discipline, is founded on the limited supply of resources in a finite world. Yet in almost every formal model of the economic system, the environment has no meaningful role to play. This remains true despite the burgeoning literature on resource depletion and environmental pollution over the past two decades. These remain specialized and isolated branches of economics with little or no impact on the mainstream of economic theory, even though there is by now a popular awareness that there must eventually be an end to human rapacity and waste.

The essay has been written against the background of an assurgent economic liberalism that is carrying almost all before it. Cutting a swathe through a diverse literature on external effects, property rights, transaction costs, welfare, and growth, it has given rise to an environmental strategy called here the market solution. The three legs of this strategy are the sovereignty of the individual, the sanctity of private property, and the domination of the present. Its effect is to justify the abdication of our collective responsibility for the outcome of our actions. Although it supposes that we can see and even make our own future, the strategy generates increasing uncertainty and myopia. It may believe that we can resolve the conflicts of interest arising out of unexpected environmental effects by the simple act of allocating property rights and establishing contingent markets, yet it generates ever more pressing sources of dispute.

By exploring the time behavior of a jointly determined economy-environment system, this essay tackles the theoretical implications of the environmental blindness that underpins the formal foundations of the market solution. Building on the one set of economic models that



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makes a serious attempt to explain the implications of the drive to accumulation in modern economies, the classical growth models, it seeks to establish just what the price mechanism can be expected to do in an economy-environment system and what it cannot. The classical growth models are not, however, the only sources tapped. Indeed, the essay has roots in a very disparate set of contributions to a wide range of debates. Some – those within economics in particular – are discussed explicitly. Others are present only as implicit influences. Because they have been important influences, however, it is worth making at least a general acknowledgment of their contribution. The anthropological literature on primitive economies has been a fruitful source of comparative insights into the management of economy-environment relations – as will be made clear. Similarly, the historical work on ancient and feudal economic systems in Europe has proved very suggestive, as have the classical and Marxian debates on the nature of accumulation in the periphery of the world economy – at the interface between capitalist and noncapitalist forms of production. Since the environment to an economy may include human as well as nonhuman systems of production, coercive systems of production such as the slave, feudal, or corvée systems are directly analogous to the more familiar exploitation of nonhuman environments. For this reason, the debates on the dynamics of such systems have been particularly illuminating.

More directly, the essay is a response to the now very numerous American contributions to the economics of the environment, and particularly to the original work on mass-balance systems by Ayres, d'Arge, and Kneese. These have added a great deal of importance to our understanding of the links between economy and environment. They have brought the environment to center stage in at least one branch of economics, and have raised important questions about the environmental assumptions ordinarily made in economic theory. At the same time, however, because most of the works building on the foundations laid by the mass-balance models have been unable to escape the trap of static neoclassical allocation theory, they have failed to address the crucially important implications of the conservation of mass for the time behavior of the system.

It will be apparent to even the most casual reader that I owe a considerable intellectual debt to Georgescu-Roegen. Not only has he tackled many of the same problems, but his penetrating remarks on the parallel time behavior of material and energy systems have provided a central reference point for the essay. He might not approve its arguments, and he is certainly not responsible for its deficiencies, but with-

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out his pioneering studies I could not have begun to ask many of the questions most central to the book.

In addition, I am indebted to a number of individuals and institutions whose support has sustained the effort required to produce the work. The University of Auckland has provided both an environment conducive to work of this sort, and most of the financial support needed to carry it out. To colleagues Geoffrey Braae, Kenneth Jackson, and Martin O'Connor I am grateful for various fruitful discussions. To Shula Marks and members of the seminars of the Institute of Commonwealth Studies, University of London, where much of the preliminary work was done with the support of a Henry Chapman Fellowship, I owe such understanding as I have of primitive economies. Alan Rogers provided a valuable testing ground for the logic of the arguments advanced, although the usual disclaimer applies. Walter Birmingham brought a fund of experience and common sense to his comments on earlier drafts. Donald Katzner made very helpful comments at various stages in the development of the work. I have also benefited from the comments of the editors and readers of the journals in which preliminary results have been published, from E. K. Hunt who read the manuscript, and from the patient and insightful suggestions of Colin Day of Cambridge University Press.

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## Notation guide

Because the basic arguments of this book are developed mathematically, and since this involves frequent use of notation, the following guide is provided for ease of reference. Uppercase bold letters denote matrices, lowercase bold letters denote vectors, and lowercase roman and Greek letters denote scalars. Columns within a matrix are denoted by an indexed, lowercase, bold letter. Rows within a matrix are denoted by an indexed, lowercase, bold letter with a horizontal bar below. Symbols that are time indexed are followed by a scalar, usually  $k$ , in brackets.

- $\mathbf{A}(k)$  = a gross input coefficient matrix
- $\mathbf{A}_\Delta(k)$  = a gross input coefficient change matrix
- $\mathbf{B}(k)$  = a net output coefficient matrix
- $\mathbf{B}_\Delta(k)$  = a net output coefficient change matrix
- $\mathbf{e}$  = the unit vector
- $\mathbf{I}$  = the identity matrix
- $\mathbf{j}(k)$  = a row vector of control variables
- $\mathbf{J}(k)$  = a controllability matrix
- $\mathbf{k}(k)$  = a column vector of control system outputs
- $\mathbf{K}(k)$  = an observability matrix
- $\mathbf{M}(k)$  = a feedback matrix
- $\mathbf{p}(k)$  = a column vector of prices
- $\mathbf{q}(k)$  = a row vector of resource quantities
- $\mathbf{q}_R(k)$  = a row vector of residual quantities
- $\mathbf{q}_E(k)$  = a row vector of excess demands
- $\mathbf{r}(k)$  = a column vector of process revenues
- $\mathbf{u}(k)$  = a column vector of unemployment rates
- $\mathbf{v}(k)$  = a column vector of investment rates
- $\mathbf{w}(k)$  = a column vector of rents
- $\mathbf{X}(k)$  = a gross input matrix
- $\mathbf{y}(k)$  = a column vector of net incomes
- $\mathbf{Z}(k)$  = a net output matrix