Book Review

William D. Nordhaus, *The Efficient Use of Energy Resources* (New Haven, Conn: Cowles Foundation, Yale University, 1979), Monograph 26, 183 pp.

Professor Nordhaus is concerned in this book with the use of energy resources and the application of economic theory for understanding this issue. Three classes of energy resources are identified: (1) inexpensive oil and gas, environmentally and economically attractive; (2) abundant, more costly, but environmentally less attractive resources, such as coal; and (3) superabundant, almost limitless, resources—including fusion, solar, etc.—which are not wholly proven and are expensive.

The efficient use of resources implies that cheap resources will be used before the expensive ones, which will have a rent or royalty associated with them, consistent with the Ricardian theory of rent. Consider time t when a particular resource (R_i) is exhausted and a new energy resource (R_j) is available to be substituted for it. The royalty on R_{it} must be equal to the price of the new resource, R_{jt}. The present price of R_i, then, is the discounted value of its price at the time of its exhaustion. This is the efficiency price.

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In Chapters 2 through 4, Nordhaus develops an econometric model, designed to trace the path of this efficiency price. It has two components: a "demand" side and a "supply" side. In Chapter 4 the two sets of equations, brought together within a linear programming framework, permit allocating and pricing exhaustible resources. The model yields price elasticities of demand for energy in the range of -0.5 to -1.0.

The efficiency price of oil is \$3/bbl for 1975 (in 1975 dollars) with a high–low range of \$2.03–\$3.71. This compares with an actual price of about \$11/bbl in 1978 (in 1975 dollars). This discrepancy—\$3 versus \$11/bbl—must be due to the monopoly position of OPEC. Nordhaus demonstrates that a wise monopolist would set a price at slightly below the level of the lowest-cost substitute of \$19. Within OPEC there appear to be at least two schools of thought: (1) the "hawks" (including Libya, Iraq, and others), who seek fully to exploit the short-run monopolistic position of the cartel; and (2) the "doves" (represented mainly by Saudi Arabia), who are concerned with the effects higher prices will have on the world economy. Nordhaus notes the presence of "irrational elements" and the possibility that "any further substantial rise in the price of oil would take price well above the long-run monopoly price." He concludes that if OPEC wishes to maximize its wealth between 1975 and 2005, oil prices would increase at about 2 percent per annum in real terms.

In Chapter 5, Nordhaus deals with the efficient allocation of resources over time. He employs the concept of "backstop" technology, defined as the ultimate technology, based on superabundant resources. He finds that (1) nuclear power will be used for generating electricity; (2) in the residential area, reliance will be placed on natural gas, supplemented by synthetic gas and displaced by nuclear; (3) coal will be used for industry; (4) in transport, natural oil will be supplemented by synthetic oil and succeeded by nuclear power. All these technologies will be succeeded by backstop technologies based on nuclear power—LWR, FBR, and HTGR; solar central electricity generation; and inexhaustible liquid or gaseous fuels—around the period 2080–2090.

In Chapter 6 Nordhaus estimates, quantitatively, market power in international gas and oil. As of 1975, prices of all energy products except petroleum were relatively close to their efficiency prices. For petroleum and gas, the efficient royalty was considerably below the current world price. It is tempting to conclude that this disparity is due to the oil cartel. Several alternative models are alluded to, confirming that the price rise of the early 1970s can be related to the effective monopolization of international oil markets. Any rise in prices of oil above the \$10–\$20/bbl range (in 1975 prices) would take prices well above the long-run monopoly price.

In Chapter 7, the world energy market is evaluated for (1) market power, (2) differential taxation, (3) lags in production and consumption responses, (4) technological changes, and so on. Mathematical programming algorithms are employed, aimed at finding equilibrium solutions under alternative conditions. The market model used here contrasts with the efficiency model used earlier.

Finally, in Chapter 8, Nordhaus investigates the possibility of major climate modifications from the "greenhouse effect" if the burning of large volumes of fossil fuels continues into the next century.

The strong merit of this book is that the author exploits the power of economic

theory to gain deeper insights into the energy problem. The book omits many of the empirical details found in other, more extensive books. One can make two major comments about it. It is doubtful that any well-honed model can adequately allow for uncertainties that will occur over the long run in the real world. These can affect rates of conservation, supplies of alternative fuels, the rate at which new technologies are developed, and the behavior of governments. The "efficiency prices" Nordhaus develops will surely be affected by those uncertainties, which in turn will affect the predictions of his models. He treats the carbon dioxide problem and its greenhouse effects as an "externality" and proposes a "carbon tax" so its social effects will be internalized. Nordhaus's proposals have been criticized and alternative solutions have been suggested by others. Debate on this issue would have been advanced if he had demonstrated the superiority of his own solution and the weaknesses of alternative proposals. One must, indeed, wonder if the simple imposition of a "carbon tax" can deal adequately with a problem as complex and ill understood as the long-run effects of CO_2 on global climate conditions. His approach does not take account of the National Research Council view "that it would be desirable to develop a new societal macroeconomics" for dealing with climate changes, or that "certain traditional techniques of cost-benefit analysis using discount rates are thus questionable in their application to climate values."[1]

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1. National Research Council, "International Perspectives on the Study of Climate and Society," Report of the International Workshop on Climate Issues (Washington, D.C.: National Academy of Sciences, April 1978), pp. 20 and 21.

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