

## Book Reviews

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Edward A. Hewett, *Energy, Economics, and Foreign Policy in the Soviet Union* (Washington, D.C.: Brookings Institution, 1984). 240 pages.

The Soviet Union has a large continental economy. It produces and exports significant amounts of oil and gas. And it is a global superpower. Inevitably, therefore, decisions and events in Soviet energy industries are important to a wide variety of people in business and government around the world. Such people, and many energy economists as well, will want to have this very useful book at hand. In four tidy chapters the author discusses Soviet energy supplies, consumption, energy "balances," and their relations to foreign policy.

Hewett's analysis both extends and augments previous work on Soviet energy (for example, Robert W. Campbell, Leslie Dienes, Theodore Shabad, Jonathan Stern, and David Wilson). It is less detailed on supply and demand issues than many earlier works but offers greater breadth. Hewett thoroughly examines the interaction of demand and supply and carefully assesses the foreign-policy implications of the analysis. For the latter alone, the book will be valuable in the continuing debate over U.S. policy toward the Soviet Union.

Hewett is more a "Soviet-type" than an "energy" economist. He has written extensively on Soviet trade in natural resources. For the uninitiated, he realistically (and fairly) sketches the workings of modern-day central planning; it works poorly but passably, and above all durably. The Soviet system is reasonably efficient at reducing the heat rate in electric generation but poor at inducing industrial managers to use energy more efficiently or to make products that use less energy. Several nice turns of phrase help convey his message. "... The five-year plan sometimes contains as much hope as it does hard projection" (p. 11). The Soviet economic system operates in an "habitually chaotic way," that is, "particularly wasteful in forced-draft situations such as the development of [the West Siberian gas] fields" (p. 75). And "the system is the final arbiter" of the consequences of planners' policy choices (p. 130).

Hewett's energy economics is quite solid, too. He is at ease with the technical aspects of both supply and demand and has no trouble traversing such treacherous terrain as "conservation" (as on pp. 111-12): "Economic considerations are so all-pervasive in energy-demand management that there is no way to be sure that every reduction in a country's energy-GNP elasticity is indeed in the best interests of the economy or that every increase is automatically a bad sign." He could perhaps use a bit more work on the economic interpretation of resources and reserves (p. 28), but the problem here is not serious.

Hewett ably documents the recent surge of investment in the energy industries. Coal, oil, and natural gas received more than a quarter of total industrial investment (excluding rather sizable transportation outlays) in 1982 compared with about a seventh in 1970. For the five-year plan period 1981-1985, investment in the "fuel-energy complex" (fuels, electric power, and pipelines) was planned to increase 50 percent over 1976-1980 compared with 10 percent for all investment and 23 percent

for all industry. Of the planned five-year *increment* in investment, this complex was scheduled to claim a full two-thirds! The surge in investment points out not only the high priority assigned to energy but also the steady upward cost trend. Planned additions to oil capacity in 1981–1985 were 7 million barrels a day, versus anticipated declines in old fields of 6.38 million barrels a day. The oil industry claimed two-thirds of investment (excluding transportation) in primary fuels in 1982.

With natural gas, Hewett finds the main supply problem to be absorptive capacity, not resources. "The binding constraint in this industry is organizational, and therefore not something for which imports or more rubles can fully compensate" (p. 83). With coal, he adduces to severe depletion (adjusted for quality), all-too-typical technological weaknesses, and unrealistic, uninformed planning production to explain the failure to achieve anywhere near the plan targets set in the mid-1970s.

On the demand side, Hewett concludes that the USSR "apparently overconsumes energy by a significant amount" (p. 105). Worse, its overall energy-GNP elasticity actually *rose* between 1974 and 1982. What slowdown there was in the rate of growth of energy use is "totally explainable (and then some) by changes in the growth rate of GNP" (p. 102). Thus, a key research issue is "whether Soviet planners can somehow manage to emulate in the 1980s what Western industrial countries achieved in the 1970s" (p. 105). A review of Soviet literature and evaluation on whether the system is likely to produce the needed decisions and actions leave Hewett skeptical that they can do so.

The chapter on energy balance is really an analysis of Soviet energy export policy. For Hewett, the primary determinants are derived demand for convertible foreign exchange and a presumed political calculus regarding subsidized ("soft"-currency) sales to Eastern Europe. He clearly lays out the interaction between oil and gas, both for export and as domestic substitutes. Without precise knowledge of either the relative weights attached to the determinants or the constraints confronting Soviet leaders, we cannot be certain precisely where the balance will be struck. Most likely this balance will shift within definable but narrow limits as market conditions change (e.g., as real world oil prices rise or fall).

Hewett attempts to project Soviet energy balance to 1990. With macroeconomic uncertainties heaped upon those in the energy sector, the exercise scarcely seems worth the effort. One can only guess why he bothered—perhaps because of the Everest factor ("because it's there") or perhaps because we in the United States have so long miscast energy policy issues in gapological terms. Fortunately, the few pages devoted to these projections do not seriously mar his overall analysis.

Fears that the Soviets will use the "oil weapon" or embark on "resource wars" have had a tidal quality alternately rising and ebbing since at least the early 1960s (when the USSR first resumed exporting noticeable amounts of oil). At the flood, scholars build dikes of fact and evidence, and eventually the tide recedes. Although the latest scare has subsided, it is still good to have Hewett's calm chapter on "Energy and Foreign Policy." Aptly, the chapter begins with a quote from U.S. Defense Secretary Weinberger, stewing over the "worry" that the Soviets will "try to seize the oil fields," taken from a 1982 *New York Times* article titled "Weinberger Says Outlay Is Needed."

Hewett builds his analysis around East-West relations and Soviet ties with Eastern Europe. About the former, he concludes (p. 199): "It is doubtful that the Soviet leadership ever thought seriously in the last few years about the consequences for the

economy of the deterioration of East-West relations." The benefits of good relations are "small and variable" in part because the Soviet Union has been able to do business in Western Europe (with its chronically depressed economies) through thick and thin. Such issues as "the arms balance, Poland, [and] Afghanistan" clearly outweigh putative economic gains from détente.

Eastern Europe is much more important to Soviet foreign policy (p. 212): "If there is one situation in which economic pressure associated with the energy sector will influence Soviet foreign policy, this is it." Its significance is *not* whether the Soviets will be able to "spoil" the oil market or (alternately) initiate a scramble for supplies that will cause a third oil price explosion. The Soviet Union is an oil price taker: its exports are too small to push the market around for very long. Impacts of Soviet energy exports on Eastern Europe are mainly local. On one hand, subsidized energy supplies are part of the costs of empire: "Soviet leaders . . . cannot relish the prospect of popular unrest triggered—however skillfully it may be camouflaged—by their increasing economic pressure (p. 212). On the other hand, subsidies constrain Soviet choices between earning more hard currency and reducing investments in oil and gas production. There is no magic solution to this problem. Its magnitude at any moment does not depend solely on energy variables; for instance, the emergence of Solidarity as a force in Polish politics cannot be linked just to higher oil prices. Thus, the most likely prospect is for oscillation between greater and lesser largesse. Western strategists should take this conclusion to heart, but it will not win many votes for larger defense budgets.

This is a useful book. Because it is based on 1982 figures, one hopes that in the not too distant future Hewett will update the data and modify his conclusions as needed (relatively little, it would seem) in a revised edition.

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E. R. Berndt and B. C. Field, eds., *Modeling and Measuring Natural Resource Substitution* (Cambridge, Ma.: M.I.T. Press, 1981).

This collection presents an overview of a significant area of production function research of the preceding decade and identifies several topics warranting further investigation. The editors' introduction briefly outlines the history of empirical research on parametric production functions, including the translog form (upon which these papers concentrate), which has wide application in energy and natural resource analyses. Unfortunately, the translog form is neither self-dual nor globally well-behaved; but despite its lack of robustness (see Barnett et al., 1984), it continues to enjoy broad acceptance. The book is divided into three sections: (1) resource substitution and technical progress; (2) problems arising from research; and (3) dynamic models.

In the first section, Jorgenson and Fraumeni extend an industry-level formulation of the translog model to include an explicit equation for technical change. They find that 19 of 36 industries studied exhibit capital-, labor- and energy-using but material-saving technical biases, and that technical change is decreasing over time for 24 of the sectors. Moroney and Trapani disaggregate further to analyse six four-digit SIC-code natural resource industries. Here the recurring dilemma of specifying and evaluating the most appropriate model is discussed, but no clear guidance is provided.

Griffin contributes to the energy-capital complementarity debate, but without resolution. This contentious issue rages unabated today and remains unresolved (see Gibbons, 1984 and Vinals, 1984). The final paper in this section by Kang and Brown enters this complementarity fray somewhat tangentially by arguing that of all the elasticity of substitution definitions only that of full elasticity (and not the normally reported Allen partial elasticity) is numerically invariant to omitted inputs. Even so, there remains a wide dispersion of results among the calculated full-elasticity estimates developed by Kang and Brown from several published studies. These four papers highlight the problems associated with interpreting results presented in the literature.

In the second section, Stapleton suggests that an explicit adjustment process should be specified and estimated to model long-run elasticities. Rather than resorting to imposing restrictive simplifying assumptions to accomplish this, he recommends inclusion of dummy variables in a pooled time-series, cross-section model but only "where the number of periods is *sufficiently large*" (p. 116, emphasis added). Paucity and low quality data hinder following this advice. Next, Anderson deals with problems such as the best ways to measure production and the elasticity of substitution; however, currently available data cannot support the "net output" definition recommended. He points out that the practice of assuming that prices are determined outside the model may be invalid, and therefore reliance upon Shephard's lemma in defining the estimated relationships must be reconsidered. Many published studies may be questioned on this basis.

Kopp and Smith use *pseudodata* constructed from a process analysis model to develop econometric estimates of input substitution. This implies that greater insight can be gained from the secondary model than from the primary one—a contention not proved. They conclude that separately modeling alternative technologies and greater disaggregation of materials inputs provides more information. This presupposes the availability of a suitable process model with which to generate requisite pseudodata.

The remaining papers explore dynamic models—specifications that are even more data-demanding than those already mentioned. The last paper (Berndt, Morrison, and Watkins [BMW]) distinguishes three generations of dynamic models that involve increasing complexity and larger numbers of parameters but that provide a "richer and clearer economic interpretation of the energy substitution process" (pp. 286–87). The dynamic demand papers present cogent discussions of the economic foundations, mathematical derivations, and empirical results of each approach, but meaningful comparisons among approaches are difficult due to the different objectives, assumptions, data, and specifications. Two tables in the BMW paper amply illustrate this. They report results obtained from the three genres of models applied to a single database, and although some striking similarities appear, the disparities are

bothersome. Norsworthy and Harper in their contribution erroneously attribute merely to the static formulation of most models the "observed disquieting differences" (p. 179) between results derived from the estimated cost functions and the estimated production functions, failing to recognise that because the translog is not self-dual, such discrepancies are to be expected.

A particular static equilibrium framework is investigated by Brown and Christensen. This formulation involves only a subset of inputs but yields dynamic economic effects. The total cost function is augmented by those inputs not held to be in static equilibrium. In the agricultural example, the fixed factor is land and the quasifixed factor is self-employed farm labor. The authors conclude the United States has a persistently large surplus of self-employed farm labor.

The Denny, Fuss, and Waverman simultaneous equation model uses a flexible accelerator approach to incorporate capital as a quasifixed factor input. This allows an economic explanation to replace the somewhat traditional and rather ad hoc Koyck lag formulation and development of a dynamic model based on a theory that explicitly includes adjustment costs. Unfortunately, when applied to disaggregate Canadian and U.S. data, quite disparate results ensue for similar industries with no obvious explanations for the differences.

In summary, the quality of the papers in this collection is uniformly high; however, the common threads among the papers might have been drawn tighter. The book is an excellent reference and should be studied by all modelers, both for the solutions offered and for the pitfalls identified. In production function analysis flexible functional forms quickly are becoming data constrained by the quest for ever-increasing insights. A critical point the book does not make is that such work is possible only with the existence of good quality data. It is questionable whether currently available data are up to the demands imposed by these newer specifications, and analysts might well harken to the admonitions of Morgenstern (1963) before venturing much further. In this vein, one regrets that only the Norsworthy and Harper paper provides model data for subsequent analyses. One hopes that conferences similar to the one that inspired these papers will be held and that subsequent collections will be as wide-ranging and as valuable.

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*Energy, Foresight, and Strategy*, Thomas Sargent, ed., (Washington, D.C.: Resources for the Future, 1985).

This book is a collection of essays employing advanced methods in dynamic economic analysis to study markets for energy products. The presentations are highly technical with heavy reliance on complex notations and abstruse terminology. As a result, the book is of interest to nonspecialists primarily as a measure of the degree to which economists have made dynamic theory operational in energy market analysis.

Clearly it is desirable to make such methods operational. Decisions involving energy equipment, reserves, and above-ground stocks all depend on current expectations of future market conditions. Future conditions are uncertain and depend on the decisions made by energy planners today.

A theoretically sound model of such a market should reflect the assumption that firms choose production plans that maximize expected profits over a multiperiod horizon. The existence of a market equilibrium, then, requires that intertemporal strategies of market agents are not only mutually consistent but are consistent with the way current decisions alter the future physical environment.

Rational expectations models meet these needs but are intractable in the general case. In these models, decision rules of individual agents are assumed to solve dynamic stochastic programming problems. For firms, the goal is to maximize the mathematical expectation of some objective function, usually the net present value of the production plan.

Because of these assumptions, such models have behavioral equations in which aggregate quantities are functions of the mathematical expectations of future prices and other variables. These rational expectations are endogenous unknowns. To close the system, it is necessary to relate the values of these expectations to those of other system variables. The calculation of these relations can be extremely complicated even for simple market models.

To implement rational expectations models, therefore, some simplifying assumptions must be made. One approach is to assume that decisionmakers have objective functions that are quadratic in the decision variables and face only linear equality constraints. The behavioral equations that result from this specification are all of linear form.

Such linear quadratic models have gained widespread use, most notably in the macroeconomic literature. Thomas Sargent, editor of this volume, has been an important contributor to this literature. He has collected in this book some very competent attempts to analyze energy markets with the same methods.

Rao Aiyagari and Raymond Riezman present in one paper a series of models of cartel pricing and production under uncertainty. Zvi Eckstein and Martin Eichenbaum wrote two papers. In the first, the authors consider the welfare-enhancing role of government policy in a general equilibrium model of an energy-importing economy facing a stochastic energy price. The second article presents a model of a market for a storable commodity in which production and sales may be regulated by a government agency whose goal is to stabilize the price.

Hansen, Eppe, and Roberds present a series of models of imperfectly competitive markets for exhaustible resources. Their article is concerned largely with the

methodology for obtaining equilibrium time paths for prices and quantities. An advantage of their approach is that the resulting equations are amenable to empirical estimation. In the book's final article, Epple estimates the parameters of a variant of one of these models using data from the U.S. oil and gas industry.

These efforts inspire appraisal of how successfully linear quadratic models analyze energy problems. The strongest impression is that the level of abstraction is still quite high. The models are quite stylized and most could represent equally well markets for nonfuel commodities. The article by Epple, although path breaking, illustrates the immense difficulties encountered in estimating such models econometrically.

It is easy to see that more sophisticated linear quadratic models can be constructed that better highlight some of the special features of energy markets. However, it appears that some of the most important activities can be incorporated properly only by drastically complicating models already difficult to handle. Most notable in this regard are exploration and development of, and investment in energy-using equipment.

Another quite different worry is that linear behavioral equations may seriously distort results when the actual relations are highly nonlinear. Treatment of storage in these models illustrates this problem. Storage is a short-run market factor of great importance in the contemporary oil market largely because of activities of speculators. According to the theory of storage as developed by Working, Brennan, and others, ending stocks are a highly nonlinear function of  $b \cdot Et[P(t+1)] - P(t)$ , the expected (discounted) intertemporal price spread or carrying charge. Graphically, the supply of storage curve is nearly horizontal at a carrying charge roughly equal to the unit cost of storage service but steeply sloped at lower values.

A linear model cannot adequately incorporate this phenomenon. To approximate the effect of speculative storage, this function in a linear model should be a nearly horizontal line. In this case, however, negative values of ending stocks will occur with great regularity because there is no restriction on negative values. If the curve is assigned a slope that prevents negative values from occurring, the important role of speculators will not be captured.

The assumption that the marginal cost of producers is linear in the quantity produced is also inappropriate in a short-run analysis. In most cases, the marginal cost of production curve is highly nonlinear because marginal costs rise sharply as production approaches full capacity. A linear specification is adequate if full capacity production never occurs, but such an assumption is incorrect.

In summary, these readings suggest that dynamic economic theories are not yet operational in energy market analysis. What the book does provide is a first step in overcoming these problems. It is to be hoped that this will inspire further work to overcome the problem.

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Manzoor, Alam, Joy Dunkerley, K. N. Gopi, William Ramsay, and Elizabeth Davis, *Fuelwood in Urban Markets: A Case study of Hyderabad*. (New Delhi: Concept Publishing Company, 1985).

William Ramsay, *Bioenergy and Economic Development*. CSIS Energy Policy Series, Vol. I, No. 1.

Both these books deal with the challenges confronting developing countries as they husband their energy resources. The first book examines a traditional fuel but in a commercial, urban environment. The second book looks at opportunities to apply new technologies to enhance the energy value of traditional fuels. Interest in this topic has increased since 1973 as options of replacing fuelwood with kerosene or other commercial products have become less affordable.

*Fuelwood in Urban Markets* sheds considerable light on a topic that to date has received little attention. It points out that using fuelwood as a major source of energy is not confined to rural areas and that traditional fuels can also be commercial fuels. Fuelwood trade in Hyderabad is largely in private hands, with prices determined by the market.

The study has four objectives: (1) to estimate the quantity of firewood and charcoal arriving in Hyderabad; (2) to analyze the structure of firewood and charcoal trade; (3) to analyze energy consumption patterns among households and commercial users to identify substitution possibilities; and (4) to project fuelwood consumption to the year 2000. Although dealing with only one city, the study should be of interest to all concerned with the urban fuelwood problem, both because of the general conclusions and the applicability of the methodology.

Chapter 2 and the appendices provide a thorough description of methods used to collect the data. Six questionnaires were employed—three involving samples and three censuses—to trace fuelwood through the distribution chain from entry into the city to final consumer.

Results of the household consumption survey are particularly interesting. Although firewood provides only 40 percent of total household energy consumption in Hyderabad, it is the most important fuel for cooking. Fuel mix varies considerably with income level, with wood being most popular among poorer households. As incomes rise, wood's share of consumption falls relative to those of kerosene and LP gas. At middle income levels, the share of kerosene also falls relative to that of LP gas. Charcoal's share is small but persistent throughout all income levels, revealing perhaps a strong preference for specialized foods prepared over charcoal.

Measured on the basis of Btus of heat content, total household energy consumption does not vary greatly with income. However, higher-income families switch to more efficient fuels, thus generating more efficient energy use from the same Btu input.

Analysis of expenditure data shows that fuelwood is an inferior good: a 10 percent rise in income results in an 8 percent drop in fuelwood expenditures. Income elasticity of demand for total household energy consumption is estimated to be 0.256. Thus, energy's share of the total budget falls as income rises.



Fuelwood consumption to the year 2000 is projected to rise slowly at about 1 percent per annum. This is the result of two countervailing forces: population growth, particularly among poorer households, and interfuel substitution.

A shortcoming of the study is that it was unable to access supply sufficiently to determine if the current yield is sustainable and whether the forecasted increase in demand can be met without substantial increases in price.

In *Bioenergy and Economic Development*, Ramsay has written a very readable and useful guide for the bioenergy planner in the developing world. Emphasis is not on engineering and cost data, which are assumed to be available elsewhere, but on economic and social factors that constrain or support individual bioenergy projects. Ramsay identifies major pitfalls and provides recommendations for overcoming them. Care is taken to explain interactions of the project with its environment—physical, economic, and social—and the relationship of bioenergy to national planning. The purpose of the book is not one of advocacy, but Ramsay clearly is an enthusiast.

The discussion of environmental effects is especially good. He devotes two chapters to the subject, separating the environmental concerns of bioenergy crops or feedstocks from those related to bioenergy conversion processes. Soil impacts such as erosion and infertility are the major problems of the former, whereas air and water pollution are the problems most associated with the latter. Despite the frequent association of bioenergy with "soft path" solutions to energy problems, Ramsay makes it clear that environmental impacts are not always benign. In fact, the environmental impact of some conversion processes can be comparable to those of the oil and gas or coal industries, although usually on a smaller scale. In this case, planners can take some comfort in knowing that control technology for these processes is readily available.

The choice of bioenergy feedstocks involves many tradeoffs. For example, the fastest growing species may require the most fertile environment, thereby necessitating the use of fertilizer that will increase costs. Other important factors influencing the choice of species are resistance to pests and disease, water and nutrient requirements, and the ability to regrow readily from the stump after the tree has been cut down. With field crops, a major consideration is that some of the most efficient converters of solar energy to biomass, such as grains and sugar cane, are also highly valued as sources of food and feed. At current prices, these crops are more profitable for food consumption than for fuel production.

Arguing that the generation of bioenergy from wastes is an excellent idea, Ramsay stresses that the use of wastes frequently entails opportunity costs. Animal and crop wastes are already intensively used, especially in subsistence agricultures, as fertilizer or as a fuel in primitive stoves. Use of these products for bioenergy could directly result in lowering soil fertility; however, the production of biogas (fermentation to methane) from such wastes may well be economically attractive. The advantage of biogas is that most of the nitrogen is preserved in sludge that can be returned to the soil, so both energy and fertilizer are obtained from one source.

Infrastructure problems are potentially very serious. Transportation and problems of information dissemination receive a fair amount of attention. Marketing problems seem to receive short shrift, especially since Ramsay contends that, "It is probably a safe guess, however, that more renewable energy projects have come to grief through

omitting a thorough investigation of potential markets than through any other cause."

Three chapters of the book are devoted to industrial organization. The main conclusions are that large-scale commercial facilities are relatively unusual at present and that many of the successful projects are characterized by a high degree of government involvement, including market intervention.

One drawback of the book, a paradox in light of its title is lack of a rigorous examination of bioenergy's role in economic development. Emphasis instead is placed primarily on integrating bioenergy projects into national planning.

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