Book Reviews

James Plummer (ed.), *Energy Vulnerability* (Cambridge, Mass.: Ballinger Publishing Company, 1982).

Philip K. Verleger, Jr., *Oil Markets in Turmoil: An Economic Analysis* (Cambridge, Mass.: Ballinger Publishing Company, 1982).

Paul W. MacAvoy, *Crude Oil Prices as Determined by Market Fundamentals and OPEC* (Cambridge, Mass.: Ballinger Publishing Company, 1982).

Since 1973, a host of domestic economic woes have been blamed on the "energy crisis" or, more correctly, the "oil problem." While virtually everyone has expressed dissatisfaction over both this country's continued dependence on foreign oil sources and its vulnerability to an interruption in supply from those foreign sources, there has been no real agreement on the "cost" of either dimension of the problem, or on the optimal policy response during an oil supply disruption. The combination of potential oil supply disruptions and overdependence on oil imports constitutes the basis of the American "energy vulnerability" problem.

The resulting problem for economic policy, which goes hand in hand with much of the revolution in economic thought and method in the past decade, has focused on the general equilibrium effects of government policy changes. Quantitative policy analysis in the energy area, as in other areas, must (1) properly define the problem, (2) formulate appropriate policy responses, and (3) ascertain the linkage between the policy mechanism and the problem.

Three recently published books from Ballinger Publishing Company address this set of analytical and policy issues—*Crude Oil Prices* by Paul MacAvoy, *Energy Vulnerability*, edited by James Plummer, and *Oil Markets in Turmoil*, by Philip Verleger. Not for the casual observer, they are detailed analyses of the short-run problems faced by the United States as a result of oil shocks. While each discusses the framework of the problem, quantitative analysis is used to support the propositions put forth (although in the first two, technical detail on the underlying modeling efforts is moved to a series of appendixes intended for a more technical readership).

The MacAvoy study is an analysis of the market fundamentals in oil pricing outcomes—supply and demand. Using different assumptions about the underlying parameters of each, he projects the path of (real) oil prices. Central to the story is a comparison of "market outcomes" and "OPEC outcomes." Given basic trends in the world oil market, might a "free market" deliver a time path of prices not unlike that produced in an OPEC-dominated or cartelized market? Extending the results from

his very interesting *New York Times* column on the same subject two years ago, MacAvoy's answer is a qualified *yes*. For the 1980s, he predicts that "the more substantial effects on prices and production follow from demand changes and from the re-entry of Iraq–Iran production, not from cartel operations" (p. 74).

Energy Vulnerability represents the collected efforts of ten economists. The approach to the energy problem is almost encyclopedic in scope. There are articles on the definition of the problem, OPEC modeling, stockpiling, the macroeconomic costs of disruptions, alternative energy technologies, consumer country cooperation, and directions for further policy. All are tied together by the objective stated by Plummer in the preface: "to use quantitative and analytical techniques to study the impacts of oil supply disruptions and the kinds of national policies that could help reduce those impacts."

Concentrating on the short-run issue of "energy vulnerability," Plummer et al. center their ideas around an oil import "premium," a concept used to quantify the net benefits of alternative energy vulnerability policies.[1] The two basic measures used (p. 7) are the *oil stockpile premium* ("the expected dollar economic benefit, in terms of lower losses in disruption years, of adding a barrel of oil to stockpiles during normal years") and the *oil import reduction* premium ("the dollar economic benefit of reducing oil imports by one barrel"). In developing policy responses toward taking advantage of the premia, the various individual analyses emphasize stockpiling, policies to reduce the macroeconomic danger, policies to reduce oil imports, and policies to address Persian Gulf military and political security.

Verleger's book is narrower in scope than Plummer's volume, but it devotes great detail to the very important issue of oil market behavior during disruptions. His focus is on the very short-run—the immediate impact on oil prices, which are adjusting to rebalance supply and demand after severe shocks. His book "describes the forces that push prices beyond the equilibrium levels by specifying the behavior of the oil market during disruptions" (p. xxv). Hence, in contrast to the more general discussion of OPEC and oil prices in Plummer's book, he concentrates on the spot market for petroleum products, the market in which supply and demand are equated at the margin. The analytical link is completed by a demonstration that the spot price, in turn, determines the world price.

Verleger devotes the first part of the book to a detailed (and somewhat ponderous) analysis of the behavior of oil markets, with emphasis on the OPEC pricing process, the role of inventory behavior in the process, and the adjustment of consumer prices to OPEC price changes. With the spot market and the spot price enjoying such a central role, analysis of alternative policy responses is simple. One need look only at the effect on the spot market and use the following criteria: "Successful

1. A problem with the premium simply defined is its partial equilibrium quality. The idea that the various premia may be added up—as in earlier work by Plummer (1981)—ignores the possible substitutability or complementarity among the measures. More important, an approach that emphasizes the macroeconomic impact of oil supply disruptions makes one realize that it is impossible to assign a specific value to the "oil import premium" without considering the state of the oil market at any given time and without making it conditional on underlying economic policies. It is nonetheless a conceptually useful device that Plummer exploits well.

measures stop the process of price increases" (p. xxv). To this end the last five chapters are devoted to policy analysis, specifically dealing with oil price controls, taxes and tariffs, stockpile management, and demand management.

There is some common ground beyond the most general level among the three studies. Both the MacAvoy and Verleger volumes emphasize the market determination of oil prices. All the studies, moreover, bring up the importance of stockpile coordination; I will discuss this in more detail later.

There are differences, however. Aside from pointing to the need for more oil stockpiling, the Plummer volume emphasizes (1) the importance of macroeconomic transmission of shocks (such as wage rigidity, higher interest rates, and short-run current account problems), (2) potential gains from joint (international) action, and (3) the promotion of alternative (backstop) technologies with short lead times. To these ends, the contributors see as directions for future policy a preference for public stockpile management over tariffs (indeed, they feel that the optimal tariff is zero) and the development of new institutions for expanded private-sector stockpiling.

In keeping with his concern over the oil price movements in the early stages of an oil shock, Verleger concludes that prices to consumers should be allowed to rise quickly. To that end, his primary policy recommendation is a large, immediately imposed disruption tariff so that consumer prices can rise much faster than under OPEC's inertia. He also recommends other demand restraints. Other than for coordinated actions of tariffs, he does not see much of a role for international cooperation. "International cooperation is a good idea but not essential to meeting a disruption. Further, the present structure of international cooperation as set up in the International Energy Agency is counterproductive" (p. xxx).

In comparing the analyses in the proposals offered in the three studies, I will concentrate on four questions. What are the dynamics of the operation of the world oil market that lead to the problems we have witnessed? What are the economic costs of oil supply disruptions (transmissions and parameters)? How important are energy-economy interactions? How does our understanding of these mechanisms influence the choice of policy responses?

OIL MARKET DYNAMICS

In *Energy Vulnerability*, Dermot Gately reviews the implications of various descriptions of OPEC decision making, asking how OPEC might respond to a change in demand and how that response might affect any monopoly influence that consuming countries have. He finds that OPEC retaliation would reduce but not eliminate price reductions gained by demand reductions. The modeling evidence comes from Gately's own work and from the World Oil Study of the Stanford Energy Modeling Forum. In another chapter in the book, Hung-Po Chao and Alan Manne use a "price-reaction function" to measure the impact on oil prices of changes in demand. A price-reaction function emphasizes potential energy-economy interactions by allowing a feedback from the decline in oil demand (because of higher prices and reduced economic activity) back to oil prices. The Plummer volume does not, though, attempt to examine the short-run impact on oil prices of oil supply disruptions.

MacAvoy goes into much more detail on market factors, econometrically estimating oil demand and supply functions by consuming and producing region, respectively. The reader must be puzzled by this effort, however. The two-stage least-squares estimates of the price and income elasticities in the demand equations are not significantly different from zero. Moreover, consumption and inventory demand, which have different determinants, appear to have been aggregated. Having not obtained estimated elasticity values, he relies on elasticity estimates in the literature to construct his simulation model: "Stipulated elasticity coefficients have been inserted into the structural equations and used to solve the model for equilibrium prices and quantities. This is repeated with alternative coefficients to provide different solutions. The solution set of simulated prices and quantities that most closely approximates actual prices and quantities in certain years is then used as the source for the estimated values of the elasticities" (p. 27).

As a result of his simulation exercises (the computer programs for which are given in an appendix), MacAvoy concludes that OPEC's influence over oil market outcomes is often overestimated. For instance, he finds that over half of the 1974 price increase "would have occurred in the open market" (p. 56). He does, however, give proper attention to the role of supply interruptions in raising oil prices. Regardless of the market structure assumed, it is that phenomenon which deserves more attention in the economic and policy debate.

It is in this area that Verleger's work is particularly strong. His analysis describes the behavior of oil markets during shocks. As mentioned earlier, his principal variable of interest is the "spot value" of oil, that is, the market value of petroleum products that could be extracted from a barrel of crude oil. To forecast the spot value, he uses a kind of price-reaction function. Two main problems with his approach are the elimination of energy-economy interactions (by taking income as exogenous to his model) and grouping the entire OECD in the demand sector of the model.

Perhaps most novel in Verleger's methodology is his discussion of the behavior of private oil inventories, an area that has been rife with explanations but short on analysis. He presents important evidence on the contribution of inventories to the price runups during supply disruptions. After a lengthy discussion of the behavior of private stocks during the past two crises, he proposes an economic model of private inventory accumulation emphasizing the speculative motive. Firms will seek stocks in addition to working levels as long as the expected future price exceeds the current price, plus financial and physical carrying costs over the period. Such an approach makes good sense. Verleger modeled the inventory level as a function of its own lagged value, the sales level, and expected future profits. By his own reckoning, the statistical results were adequate but not good. The estimated coefficients had large standard errors. The coefficient of the profit variable was marginally significant for the OECD as a whole, but insignificant for the U.S. alone. Isolating a speculative motive in private inventory behavior has important policy implications. To the extent that such behavior is forward-looking, policies that can manipulate expected future prices (through use of the Strategic Petroleum Reserve, for example) can be useful in blunting disruption-induced price increases.

In explaining his results, Verleger points out that stock levels, price controls, and unexpected demand changes also affect measured inventory levels. Elsewhere,

I have taken account of these factors and estimated an equation for U.S. private stocks that considers the change in the oil inventory-to-sales ratio as the variable to be explained (Hubbard and Weiner, forthcoming). The expected profit from holding an extra barrel of oil over the coming period is measured as the difference between the expected price next period and the price today (adjusted for interest costs), where the price used is the marginal cost of a barrel of oil to U.S. refiners.[2] A second variable reflects the fact that stock adjustment is not costless by comparing the inventory-to-sales ratio last period with a moving average. (If last period's value is high relative to trend, there is a gradual movement back.) Finally, a "demand surprise" term captures the fact that higher-than-expected demand will result in stock depletion, since contract renegotiation is gradual. (The "surprise" term is measured by a moving average.)

It would be useful to combine the approaches of the three volumes in such a way as to capture the importance of market fundamentals and energy-economy interactions, the role of private stocks, and the impact of international stock coordination policies. Essential to such a concept is a rigorous notion of market tightness. As Verleger points out, the spot market acts as a signal of market disequilibrium to OPEC. The spot price increases when the market "tightens." Two forms of tightening are possible: demand can increase due to changes in consumption or inventory accumulation and supply can decrease due to disruption in a producing country (or deliberate production cuts). To capture both effects, let

$$\Delta P_t = f(S_t/S_t^*), \qquad f' > 0 \tag{1}$$

where P is the crude oil spot price and S and S^* refer to actual and capacity OPEC production. Other oil prices can be obtained from, or as adjustments to, the spot price.

Let capacity decisions be determined by long-run considerations (adjusted during disruption, of course). For example, MacAvoy discusses the exploration and reserve addition process underlying oil supply decisions. The world supply of and demand for oil must be equal, so

$$(D^{US} + D^{RW}) + (I^{SPR} + I^{US} + I^{RW}) = S + S' + S^{NO} \tag{2}$$

where US stands for the United States, RW for the rest of the world, D for consumption, I for stock change, SPR for the U.S. Strategic Petroleum Reserve, S for the production of nondisrupted OPEC producers, S' for the (reduced) output from disrupted producers, and S^{NO} for non-OPEC production. S can be obtained in terms of consumption, stock change, and production by other countries as

$$S = (D^{US} + D^{RW}) + (I^{SPR} + I^{US} + I^{RW}) - (S' + S^{NO}) \tag{3}$$

Hence, (1) can be rewritten as

$$\Delta p_t = f\left(\frac{(D_t^{US} + D_t^{RW}) + (I_t^{SPR} + I_t^{US} + I_t^{RW}) - (S_t' + S_t^{NO})}{S_t^*}\right) \tag{4}$$

In addition to being able to examine the effects of SPR decisions and private and foreign stock decisions, energy-economy interactions can be considered through

2. See Hubbard and Fry (1982) for definitions and details.

D^{US} and D^{RW}, which depend on oil prices (which in turn depend on the OPEC spot price). Neither MacAvoy nor Verleger pay much attention to these linkages, although the endogeneity of income with respect to oil price shocks is important for oil market outcomes as well as for general policy interest. In Hubbard and Fry (1982), the formulation above is linked to a model of the world oil market and the U.S. economy and used to analyze the impacts of various policies.

MACROECONOMIC COSTS OF DISRUPTIONS

Another stream of analysis essential to the formulation of policy responses to oil shocks is an examination of the macroeconomic costs of oil supply disruptions. Professor MacAvoy's book is devoted only to the oil market; energy-economy interactions are not within the scope of his analysis. There is very little treatment of energy-economy linkages in Verleger's book, although he does illustrate well the importance of macroeconomic considerations in his discussion of oil import tariffs. The Plummer volume is particularly informative in this area, thanks to the chapters by Knut Mork describing the background of and results of the macro-energy model designed by Mork and Robert Hall.

After reviewing the basic transmission mechanisms that affect the economy's aggregate demand and aggregate supply, Mork emphasizes a "classical" approach, in which the main problem is a shift in relative prices coupled with sticky wages and prices in the economy. He points out (quite correctly) that the magnitude of the demand-side loss of a disruption depends on the level of oil *consumption*. While the effect of an oil shock on the current account may be transitory and ambiguous, depending on the set of underlying fiscal and monetary policies across the globe, it should exert its principal impact through consumption and investment. Consumption should decline because of the reduction in household wealth; investment will fall in the short run because of the drop in profitability and because of the rise in the wage share relative to the profit share.

The Mork–Hall model has a detailed energy sector involving both domestic energy production and a "price-reaction function" for world oil prices. Many interesting details about short-run movements in the oil markets are missing, since the model lacks a structure of oil prices that Verleger's system contains.

Indeed, the inattention to the short-run surfaces in the core macroeconomic model as well, which is solved on an *annual* basis. Understanding the timing of effects is crucial for policy analysis, particularly for the design of fiscal and monetary policies. These two major types of conventional policy responses are not present in great detail in the model. Monetary policy works only through the interest rate, and there is only one interest rate; expected inflation is taken as constant and is not influenced by monetary growth. Fiscal policy can affect investment through the corporate income tax rate and through the investment tax credit. Temporary income tax stabilization policies have very little effect. Despite the model's annual scope, it is a useful tool for measuring the relative economic impacts of certain policies.

In Chapter 5 of *Energy Vulnerability*, Mork simulated a control scenario and a one-year oil supply disruption of 10M mbd occurring in 1985. The results for the

disruption are difficult to interpret since the reader is not informed about the path of oil prices, nor about the underlying fiscal and monetary stance of the U.S. government. His measures of the drop in real GNP and the drop in real investment are quite large, much larger than the numbers I have found elsewhere (Hubbard and Weiner, forthcoming). Part of this may be due to differing economic policy assumption. But I suspect the principal reason is that Mork's real GNP is not the GNP as conventionally defined.[3]

Whatever doubts one may have about the magnitudes of the economic impacts of oil shocks presented in *Energy Vulnerability* (and the policy responses to deal with them), the book makes the excellent point that an analysis of disruptions must focus on those impacts and on the way in which they can, in turn, affect oil market outcomes. Quantifying these impacts and comparing them across macroeconomic models are the goals of the most recent study initiated by the Energy Modeling Forum at Stanford University. That study is still in progress.

POLICY ANALYSIS AND IMPLEMENTATION

All three volumes devote at least some attention to policy analysis and policy recommendations, although Plummer et al. and Verleger do so in much greater detail than MacAvoy. Indeed, the brief section on policy suggestions at the end of MacAvoy's book does not seem well connected with his analysis. Before touching on other recommendations of the studies, I want to discuss one in particular—the viability of the "disruption tariff." On this point, there is a substantial difference of opinion between the Plummer and Verleger volumes.

The contributors to the Plummer volume find that the optimal tariff (or subsidy) on oil imports is zero. From rudimentary economics, we know that a tax on a good may be appropriate when the good's social cost exceeds its private cost. However, as Gilbert and Mork point out in Chapter 7, this argument is not as forceful when there are price rigidities. "Since the price shock itself is a problem, a tax or tariff may only aggravate the effects on aggregate demand" (p. 160). Indeed, in their model simulations, Gilbert and Mork find that a tariff of $5 per barrel imposed by the United States alone during the disruption mentioned earlier would lower the world oil price, but would have only a minor benefit for real GNP. Even the minor gain masks a decline in investment offset by an improved current account.

Verleger devotes a chapter of his book to the tax/tariff study. In keeping with his theme of "raise consumer prices quickly," he advocates the use of a quota/auction, a tariff, or a specific tax on crude oil. (The tariff actually comes second in his preference behind the quota auction.) His simulation exercises generate significant and rapid declines in (spot market) oil prices, his criterion of benefit. The actual

3. According to Mork (in Plummer, p. 109): "Real GNP is defined here as nominal GNP divided by the overall price level for finished goods. Thus, imports are subtracted in nominal terms *before* deflation. This differs from the conventions of the National Income and Product Accounts and gives a somewhat larger GNP loss." That this adjustment is nontrivial is evident from his comment on p. 108: "If this measure is used, the decline in GNP from 1973 to 1974 is found to be 2.6 percent, rather than the official 0.6." (In the original, the final figure read "0.06," but this is incorrect—*The Editor.*)

values for the spot prices seem unrealistically high, however. (See Plummer, p. 178.) Most of the rest of the chapter is devoted to simulations of various types of tariff policies.

Of course, Verleger's simulations did not incorporate the sort of macroeconomic analysis used by Gilbert and Mork. He did, however, identify some likely economic consequences. As opposed to the emphasis of investment in Gilbert and Mork, Verleger concentrated on the fiscal drag problem and consumption, making recycling of any increase in federal revenue a major problem. He suggests that the speed of recycling could be a crucial parameter in assessing the tariff's effectiveness and points to some evidence that recycling programs can be set up quickly. Indeed, work in progress by the Harvard Energy Security Program agrees that rebate mechanisms can be set up to distribute funds in a short period of time and that a fast injection of funds may mitigate some of the short-run drop in aggregate demand accompanying the disruption.

Gilbert and Mork disputed the importance of the rebate issue, "partly because their [rebates'] effect on income is highly temporary and partly because consumers are likely to realize that the resulting increased government deficit (or reduced surplus) must be paid for some time anyhow" (p. 164). The authors recognize the importance of the rebate from the point of view of avoiding government waste, but not as a tool for economic stabilization.

While it is true that the rebate of tariff proceeds cannot offset the relative price shock, it may inject needed liquidity into the economy at the beginning of the crisis. I have argued elsewhere (Hubbard and Fry, 1982) that, while the tariff may be useful in reducing world oil prices, its macroeconomic impacts are, at best, neutral. Whether the tariff is an appropriate response stems largely from the *goals* of policy. For a goal of world oil price reduction, the tariff may be useful; for a goal of economic stabilization, temporary tax reductions (funded, say, from incremental Windfall Profits Tax collections) might be more appropriate. This is an area in which much more work needs to be done.

All three books encourage stockpiling in consuming countries as a means of reducing vulnerability to oil shocks. MacAvoy goes so far as to advocate the development of a world market in crude inventories (whose inventory-expanding policies would be similar to those of the International Energy Agency) for delivery at major refining centers. Plummer et al. and Verleger point out the potential usefulness of SPR releases in blunting severe oil price increases. Neither study goes into much detail on how the SPR might be drawn down. There are important issues there. How important are the size and timing of the release? How important are reactions from domestic private stocks and foreign stocks?

Before leaving the discussion of policy implementation, one of the more interesting analyses in either book is Plummer's "Financing Oil Proliferation in Developing Countries" (chap. 12). Plummer points out the difficulty (on the part of developing countries) in raising funds in private capital markets for oil exploration. He found not only high *direct* rates of returns to the countries, oil companies, and investment bankers that put capital into successful projects, but high *indirect* returns as well. These indirect returns come about through a fall in the world oil price occasioned by the increase in LDC oil production. Such returns make subsidies from international lending organizations like the World Bank a good idea. In the balance of the

chapter, Plummer discusses the advantages and disadvantages of setting up an "energy affiliate" at the World Bank.

CONCLUSION

Crude Oil Prices, Energy Vulnerability, and *Oil Markets in Turmoil* represent important additions to the economic discussion of oil supply shocks. The costs of the U.S. economy of oil supply disruptions have been large, and designing proper policy initiatives to combat these problems is very important.

While the studies are not well packaged for a quick examination, they are useful references for policymakers. MacAvoy's study puts the role of OPEC in the world oil market into an economic perspective. Verleger's book is particularly strong in its description of the behavior of the world oil market during disruptions, pointing out major problems and areas for future research. Because of the lack of energy-economy linkages, his specific model results should not be taken as seriously as his main point—policy intervention to reduce world oil prices must act quickly on both consumption demand and inventory demand. The strength of the Plummer volume is in setting the *framework* for responsible policy analysis to deal with disruptions. All three books are important reading for anyone concerned with the economic impacts of oil supply disruptions.

Hubbard, R. Glenn, and Fry, Robert C., Jr. (1982). "The Macroeconomic Impacts of Oil Supply Disruptions: Revised." *John* F. Kennedy School of Government, Energy and Environmental Policy Center Discussion Paper Series, (June).

Hubbard, R. Glenn, and Weiner, Robert J. (forthcoming). "The Sub-Trigger Crisis: An Economic Analysis of Flexible Stock Policies." *Energy Economics.*

Plummer, James (1981). "Methods for Measuring the Oil Import Reduction Premium and the Oil Stockpile Premium." *The Energy Journal* 2, 1 (January): 1–18.

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Herman Kahn, *The Coming Boom* (New York: Simon & Shuster, 1982).

This book is basically a series of essays connected by the premise that the so-called malaise is a very short-term thing and that the United States is on the verge (if not already in) a sustained period of economic, technical, and cultural expansion. Kahn's chapters on financing, high tech, defense, inflation, and government are the antithesis of the spate of "stranger and afraid in a world I never made" jeremiads so popular during the seventies.

The book's energy chapter, "We May Luck Out but Should Hedge," like that on high tech, exudes a high degree of optimism. Kahn's preferred scenario results in

a steady decline in demand for OPEC oil until by the end of the century exports would vanish. He arrives at this result by projecting a very slow growth of world oil demand (1.9 percent per year), large increases in oil supplies from non-OPEC sources (7 percent per year), and a rapid expansion of natural gas use (5 percent per year). On this basis, world oil prices would fall sharply long before OPEC export markets had dried up completely.

Kahn's alternative case, resulting from faster demand increases and a slower growth of non-OPEC and non-oil sources, would cause demand for OPEC oil to increase to 25M mbd by 1990. This would put renewed pressure on prices. But he considers this scenario unlikely, barring major supply interruptions.

Even for those who agree with Kahn's optimism, these analyses suffer from serious shortcomings. The two sets of energy balances he discusses seem to be unrelated to world economic growth and the relationship between energy demand, supply and prices is nowhere explained. In fact, the scenario assumptions are inconsistent: rapid demand growth implies high energy prices and a strong market for OPEC oil, not its disappearance. Slow demand growth implies low energy prices and a weak market for OPEC oil, not an expansion to capacity operations. There is heavy stress on synthetics as supplements to conventional fossil fuels, but not even a hint that these will be economical only if oil is tight and prices rising.

In short, his world is one in which growth curves march along at predestined rates indefinitely, without regard to how their interactions may result in periods of market weakness followed by great market strength. Recent history should have made it amply clear that any simple set of energy extrapolations can only lead to gross predictive errors

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