Volume 9, Issue 4

October, 1988

Pages 1-15

Comparative Energy Policy: The Economics of Nuclear Power in Japan and the United States

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Abstract

Over the next several decades, Japan and the United States will pursue dramatically different nuclear power strategies. In the United States, no new reactors have been ordered since 1978, and no U.S. utility is seriously planning any new construction. In contrast, Japanese utilities aggressively continue to plan, order, and build new nuclear plants, and the Japanese government and utility industry are committed to increasing Japan's nuclear reliance from 26 percent of total generation to 49 percent by the year 2010. At the core of this striking difference in nuclear power strategies are three important economic facts. The Japanese build a typical plant almost twice as fast and (not coincidentally) for as little as half the cost as their U.S. counterparts. The Japanese also run their nuclear plants at a significantly higher average capacity factor. As a result of these three nuclear advantages, nuclear power is considerably more economic in Japan than in the U.S.

Pages 17-33

The Economics of International Oil Sharing

by George Horwich (Department of Economics, Purdue University, and Oak Ridge National Laboratory) and David Leo Weimer (Public Policy Analysis Program, University of Rochester, NY, USA)

Fifteen years after the 1973-74 oil embargo, two of the programs designed by consuming countries to cope with oil disruptions are still in place. One is the strategic stockpiles of oil owned or controlled by the governments of the industrial nations. The other is the oil-sharing plan of the International Energy Agency. In fact, both programs received their impetus from the IEA, which was formed in 1974 by the United States, Canada, most Western European countries (except France), Japan, Australia, and New Zealand. The IEA requires signatory countries to hold oil stocks equal to ninety days' imports of oil (interpreted generally as an amount over and above normal working stocks). This has largely been accomplished. Oil sharing, however, is to be imposed only in the event of oil-supply cutoffs of 7 percent or more to any individual member or the group as a whole.

Although petitioned several times by individual countries, sharing has never been implemented. Neither has the program been systematically evaluated by a task force outside the IEA. This is the purpose of the study which this paper draws upon (Horwich and Weimer, eds., 1988). It should be noted that the rest of the governmental responses to disruptions (price ceilings, mandatory allocations, entitlements) have, at least in the United States, been widely rejected by professional economists and policy analysts (see Ford Foundation, 1979, chap. 1; Kalt, 1981; Lane, 1981; Couts and Horwich, 1982; Horwich and Weimer, 1984, chap. 3). This group has little enthusiasm for imposing controls in a future emergency. Among other things, it is the belief that IEA oil sharing might entail controls or encourage their adoption, domestically as well as internationally, that leads us and others to view sharing skeptically.

Pages 35-48

Integrated Energy Planning in India: A Modeling Approach

by R. K. Pachauri and Leena Srivastava (Tata Energy Research Institute, New Delhi, India)

The economic planning process in India can broadly be broken up into two steps: the building up of Five Year Plans and the specification of Annual Plans. Several planning models were used to arrive at a balanced allocation of resources for attaining the objectives and targets of growth and social welfare postulated in each Five Year Plan. The basic modeling structure has evolved over the last thirty-five years to comprise a core model and seven major submodels, viz. agriculture, industry, consumption, poverty, export and import, financial resources, demography and employment. The core model consists of (i) a macroeconomic model encompassing a number of national income and expenditure identities, (ii) an input-output model which determines the output levels needed to satisfy various sectoral demands-Aemand for public and private consumption, demand for investment (public and private), demand for exports and demand for intermediate goods and, (iii) an investment model which determines, with the help of (i) and (ii) investment requirements in the last year of the Five Year Plan (Planning Commission, 1981). The submodels are used to ensure feasibility of the output levels determined by the input-output model. The main role of these submodels is to estimate the supply potential of the different sectors vis-a-vis (i) the investment allocation made in the different plans, (ii) the rate of completion of existing projects and programs, and (iii) the utilization of the capacity available in the course of the implementation of the plan.

Pages 49-61

On the Economics of Improved Oil Recovery: The Optimal Recovery Factor from Oil and Gas Reservoirs

by Arild N. Nystad (Norwegian Petroleum Directorate, Department of Resource Economics, Stavanger, Norway)

This paper investigates an oil company's optimal depletion of oil and gas reservoirs, taking into account that the depletion policy itself influences the recoverable reserves, i.e., determines the recovery factor. The emphasis is on the role of up-front capital costs. The depletion policy is derived from the amount of investment in production and associated injection projects, represented in a stylized fashion. I make a comparative static study of how various economic factors influence the company's choice of an optimal depletion policy and, thus, implicitly of an optimal recovery factor. A distinguishing feature of this approach, as compared with the more conventional economic analyses of optimal depletion (see e.g. Dasgupta and Heal, 1979), is that it centers on the reservoir-specific relationship between productive investments and recoverable reserves. This relationship is of a geological engineering nature. My main purpose is to formalize in an economic analysis the role of the reservoir's sensitivity in the determination of the optimal recovery factor. Production from a reservoir requiring investment may not look like "Hotelling" type of reservoirs. Both the analysis and illustrative calculations, conducted on a reservoir model, suggest that this neglected aspect of the economics of petroleum reservoirs has a bearing on a number of policy issues. Its significance is also shown to vary considerably from one reservoir to another.

Pages 63-91

Taking Off: The U.S. Demand for Air Travel and Jet Fuel

Dermot Gately (Economics Department, New York University, New York, NY, USA)

Since 1965 U.S. air travel has grown three times faster than GNP. Jet fuel demand, although virtually unchanged between 1969 and 1982 because of improved efficiency in fuel use by jet aircraft, has grown 30 percent since 1982. The key question is whether fuel-efficiency improvements can keep up with the rapid growth in air travel. This paper investigates both the rapid growth in air travel and the impressive increase in efficiency of fuel use, and it examines their implications for the future. The first section below presents background information about the pertinent changes over the past two decades: rapid growth in air travel, declining ticket prices (even before deregulation), fuel prices tripling then collapsing, and fuel efficiency improvements (even prior to fuel price increases). The next section summarizes the sources of fuel-efficiency improvements. These include not only the shift toward more efficient airplane types, but also the improvements within airplane types: both in new planes and (most surprising) in existing planes through retrofitting, such as replacing engines and increasing the number of seats per plane. And fuller loading of aircraft, increasing both the number of seats per plane and the percentage of seats filled, has allowed the demand for air travel (passenger-miles) to grow more rapidly than seat-miles. The next section presents econometric estimates of three equations, analyzing passenger-miles per person, fleet efficiency, and the demand for jet fuel. One finds an income elasticity of passenger-miles that is close to 3.0. The final section describes the implications for the future.

Pages 93-94

Special Feature
U.S.-Canadian Trade Agreement: An Energy Colloquium

Editor's Note

The United States and Canada recently concluded a comprehensive agreement which calls for removing restrictions on trade between them, including energy. To explain the details of the energy portions of the agreement, we present by a series of comments by seven authors from both sides of the border. They deal with various energy sources (oil, gas, electricity and uranium) and with the situations peculiar to various geographic locations.

Pages 95-97

Background and Summary of Energy Provisions

by R.A. Reinstein (Director for Energy and Natural Resources, Office of the U.S. Trade Representative)

The United States is the world's largest energy consumer. Although it is also one of the leading producers of energy, the requirements of its economy for various forms of energy are so great that it must import significant amounts of energy to meet these needs. Canada is by far the United States' largest energy supplier. Since 1986, the United States has imported more crude oil and petroleum products from Canada than from Saudi Arabia, Venezuela, or Mexico. Canada supplies almost all of the U.S. natural gas and electricity imports, and more than two-thirds of its uranium imports. In addition, Canada is the largest U.S. coal export market. The United States and Canada share the world's largest bilateral energy trade relationship, with two-way trade of $10 billion per year or more. Regrettably, the history of this trade has been marked by a considerable degree of government intervention on both sides, in the form of export restrictions, minimum export price requirements, import fees and quotas, and various other trade restrictions. In addition, domestic programs in each country have distorted trade both in energy itself and in energy-intensive products such as petrochemicals. While these past actions have often been in response to short-term concerns, they have generally worked to the longer term disadvantage of both countries. At times, artificially low prices have stimulated excess demand while suppressing supply, thus causing shortages. At other times, artificially high prices have stifled economic activity throughout the economy, especially in energy-intensive industries. Overall, the uncertainty about future government energy trade policies and actions has inhibited investment in energy production and energy-consuming industries in both countries.

Pages 99-101

An American Perspective

Philip K. Verleger, Jr. (Institute of International Economics, Washington, DC, USA)

Energy policy has been one of the more contentious issues in both internal and external policy debates in Canada and the United States during the last two decades. From time to time each country has taken measures which are totally devoid of economic merit. Each nation has also occasionally adopted programs affecting either the importation or exportation of energy supplies to or from the other which would have triggered extraordinary responses had they been adopted under any other circumstances or affected any other commodity. In the sorry history of commercial relationships between the two countries, the United States has probably committed the greater offences. Limits on oil imports were imposed in a manner that discouraged development of Canadian oil reserves. Price controls on domestic natural gas gave U.S. industrial users of natural gas a strong competitive advantage over firms from other countries, including Canada, in world markets. Canadian uranium producers were effectively prevented from selling to the large U.S. electric utility market because they were denied access to U.S. enrichment facilities. Many Canadian actions towards the United States in recent years were also contrary to the spirit of free trade. During the Trudeau administration Canada embarked on a program to restrict exports of petroleum to the United States. At the same time, U.S. customers were denied access to price-controlled Canadian crude by a special border tax that raised Canadian export prices to world levels. Another program raised the price of natural gas exports to U.S. $4.00-$4.50/MCF, well above the competitive market level. Finally, U.S. firms were denied the right to invest in resources in Canada on the same basis as Canadian firms, while Canadian firms were encouraged to start or join in takeover attempts directed at U.S. firms such as Conoco and Gulf Oil.

Pages 103-106

Two Canadian Perspectives

Leonard Waverman (Department of Economics, University of Toronto, Ontario, Canada)

Section 9 of the Free Trade Agreement (FTA) certainly affects the policy instruments which can be used to control energy development. As crises and domestic pressures for intervention will undoubtedly arise in the future, it is interesting to contemplate how the FTA will alter oil and gas developments. Basically, the FTA prevents price discrimination against buyers in the other country through direct government action. It also prevents governments' use of exports/imports of energy to buttress domestic development of the industry - the Canadian government cannot decide to cut only exports to "conserve" oil; the U.S. government cannot cut Canadian imports to increase the supply of U.S.-produced energy. These discriminatory policies were important in the past. For example, Canadian domestic price ceilings were feasible only because exports could be priced at world price levels. The FTA thus virtually prevents the Canadian government from imposing further

domestic price ceilings for energy supplies that are exported. If the United States exports no energy to Canada, domestic U.S. price ceilings are feasible if rules allow the "rolling in" of higher-cost Canadian supplies. I argue below that substantial two-way trade is to be expected in oil and gas once the FTA is in place. As a result, Section 9 of the Agreement is not necessarily asymmetric in the constraints it places on domestic policies. Government-imposed price discrimination existed in the past because of the difficulty in sharing energy rents in federal states. At the next oil price shock, rent collection and distribution must utilize tax, not price, instruments. There is little evidence that either country has an appropriate fiscal system in place for rent collection or has sorted out who deserves what share of resource rents. The existence of the FTA makes it necessary to do these difficult tasks sooner rather than later.

Pages 107-110

On Aspects of Oil and Gas Trade

by Andre Plourde (Department of Economics, University of Ottawa, Ontario, Canada)

The core elements relating to energy trade occupy barely six of the 315 pages of the text of the proposed Canada-U.S. Free-Trade Agreement (FTA). As far as oil and gas are concerned, the basic thrust of the agreement is consistent with the attitudes favoring deregulation and increased exports that have recently characterized Canadian policy, especially since 1985. As such, these elements have been strongly endorsed by the governments of the oil- and gas-producing provinces (Alberta, British Columbia, and Saskatchewan), and by the Canadian oil and gas industry. Yet, to many Canadians, the energy provisions, especially as they apply to oil and gas trade, are controversial aspects of the FTA. During the thirty years preceding the FTA, Canadian and U.S. policy frequently operated at cross purposes on the issue of energy trade between the two countries. During the 1950s and 1960s, Canada sought to increase its penetration of U.S. energy markets, a move which was resisted by U.S. authorities, mainly on national security grounds. During most of the 1970s, the United States wished to see higher levels of oil and gas imports from Canada. For a number of reasons, including fears of chronic shortages of domestic supplies, the Canadian government adopted a nationalistic, "Canada first" policy in which export volumes were strictly controlled (and sharply reduced in the case of oil), and export prices were set higher than domestic prices. The situation was basically sustained through to the introduction of the Canadian government's National Energy Program (NEP) in October 1980. The various updates, amendments and federal/provincial agreements that subsequently modified the NEP edged Canadian energy policy toward a more favorable treatment of exports as a vent for domestic production. These set the stage for the Western Accord and the Natural Gas Agreement, which brought deregulation and a pro-export attitude to Canadian energy policy in 1985.

Pages 111-119

Electricity and Gas: The U.S. West

by Arlon R. Tussing (Arlon R. Tussing Associates, Inc. Seattle, WA, USA)

Cyclical movements in the politics of U.S.-Canadian energy trade

Canada is a country of sparse population with a vast area and natural resource potential. Most Canadians, moreover, reside in a narrow 6,000-kilometer strip on the border of Canada's more populous southern neighbor. The most efficient orientation of North American trade in resource commodities, including fuels and electricity, thus tends to be longitudinal - from north to south or (less frequently) south to north. Canada is naturally poised to be a net exporter, and the United States a net importer, of such commodities. Over the years, however, economic nationalists in both countries have sought to frustrate or overcome the logic of geography and comparative economic advantage. They have called on a variety of regulatory devices and government-aided transport projects intended to enhance latitudinal commodity movements at the expense of cross-border trade. The public rationale for these measures has generally been national self-sufficiency in energy, but most of them have evoked far more controversy and animosity among regional and sectoral interests in one country or the other than between the two nations. Not surprisingly, sentiment for or against freer trade in energy has swung back and forth across the border as perceptions of the continental and global energy supply outlook shifted from surplus to shortage and back again. For example, during the "energy-crisis" years of the 1970s, the chief obstacles to energy trade between the United States and Canada were those erected by Ottawa. The prevailing theory was that exporting any oil or gas that could be used at home, either immediately or in the future, would intensify Canada's dependence on OPEC oil or diminish the economic welfare of future generations of Canadians.

Pages 121-125

Electricity and Gas: The U.S. East

by Henry Lee (John F. Kennedy School of Government, Harvard University, Cambridge, MA, USA)

The Free-Trade Agreement (FTA) represents a continuum in the ongoing expansion of energy trade between the northeast states of the United States and Canada. The agreement will not result in dramatic changes in existing trading patterns, since the proverbial floodgates are already open, but it may provide benefits, which will grow in significance over time. These benefits include reducing the political risk that governments on either side of the border will intervene to artificially restrict trade, reducing the region's exposure to world oil disruptions and increasing the ability of buyers of energy goods and services to expand the number of supply options available to them. Energy trade - both actual and proposed - between the northeastern states and Canada increased dramatically during the 1980s. In 1986, New England and New York imported 26,000 GWH of power from the provinces of Quebec, Ontario and New Brunswick. While gas imports into the United States from Canada decreased during the early and mid-1980s, a number

of new projects were proposed to transport gas from Alberta, beginning with the Boundary Project in the early 1980s and continuing in recent months with a number of additional projects including the controversial Iroquois Pipeline. These projects would significantly increase Canadian gas sales into the Northwest. There is also a synergistic relationship between the region's electricity needs and increased access to Canadian gas. New England and, to a lesser extent, New York are confronted with short-term electricity supply problems. One of the major options proposed to bridge this gap between demand and supply has been large cogeneration facilities - 50-300 megawatts - many of which will be fueled by Canadian gas.

Pages 127-130

Canadian Electricity

by Jean-Thomas Bernard (GREEN, Departement d'economique, Universite Laval, Quebec, Canada)

Trade in electricity between Canada and the United States has been characterized in recent years by large and increasing sales from Canada to her southern neighbor. Canadian exports are subject to federal government regulation through the National Energy Board (NEB) and to provincial government approval through provincial control over electric utilities. Electricity imports in the United States are not subject to federal government regulation. However, purchases of electricity must be approved by state commissions having regulatory powers over local electricity suppliers. To what extent does the U.S.-Canada Free-Trade Agreement (FTA) change existing regulations and what will be the likely impact on cross-border electricity trade? To provide tentative answers to these questions, we will first recall the main features of the existing regulatory framework in the two countries. Then, we will review the sections of the agreement dealing with electricity in order to determine some potential effects on future trade.

Pages 131-134

Nuclear Fuel

Ted Munden (Eldorado Nuclear, Ottawa, Ontario, Canada)

Since the U.S.-Canadian free-trade agreement (FTA) envisages an open North American market for nuclear fuel, it is of considerable importance to the uranium industry. The principal beneficiaries of the agreement will be the U.S. electrical industry, which wants secure supplies of uranium at a reasonable cost, and the Canadian uranium industry, which wants to develop export markets. Canada is the largest producer and exporter of uranium in the western world. Its uranium mines and processing facilities are modern and very competitive. Canada has long been a major uranium supplier to the United States. In 1987 Canada's uranium exports to the United States were worth more than $300 million

Canadian. U.S. exports represent 40 percent of total Canadian sales. Canadian uranium producers now have unrestricted access to the United States, which accounts for about 35 percent of the western world's uranium market. Uranium trade relations between Canada and the United States have not always been this peaceful. Over the years, government interventions on both sides of the border have distorted and impeded uranium trade. Today's trend towards trade protectionism in the U.S. Congress and a dramatic decline in the U.S. uranium mining industry have set the stage for a new round of uranium trade restrictions. Despite strong opposition from the U.S. administration, there are continuing efforts in Congress and the courts to protect the U.S. uranium industry. Because of Canada's success, it has been identified as a primary target. For this reason alone, the FTA comes at a very opportune time. It addresses two specific uranium trade issues and it offers the hope that free trade in uranium will continue, with competition judged solely on commercial terms.

Pages 135-147

The Use of NYMEX Options to Forecast Crude Oil Prices

by James A. Overdahl (School of Management, University of Texas at Dallas, TX, USA) and H. Lee Matthews (Texas Oil and Gas Corp., and University of Texas at Dallas)

The recent introduction of traded options on crude oil futures contracts at the New York Mercantile Exchange (NYMEX) gives energy economists a new tool for forecasting the price of crude oil. Since the pricing of these options requires that market participants assess the probability distribution of future crude oil prices, a properly specified model of option pricing can be used to "back out" this assessment from observed option prices. The performance of this efficient-markets approach to forecasting depends on the quality of information contained in the prices of options and futures contracts. If these prices contain all available information concerning the future spot price of crude oil (including costly information), then (naturally) the efficient-market forecast will also contain this information. This means that the efficient-markets forecast will contain valuable data which can be used to enhance the forecasts of both informed and uninformed market participants. In fact, failure to consider the efficient-markets forecast will waste valuable information. Our analysis relies heavily on the theory of rational option pricing. The literature in this area is well-developed, following the seminal work of Black and Scholes (1973). In particular, we rely on a pricing model of Americanstyle options on futures contracts developed by Barone-Adesi and Whaley (1987). Our analysis also requires that the relationship between futures prices and expected spot prices be known. The remainder of this paper is divided into four parts. First, a model of how the market prices options on crude oil futures contracts is developed. Then the model is used to "back out" the market's implied assessment of the probability distribution of future crude oil prices. The next section uses observed market prices to produce efficient-markets forecasts. The last part offers conclusions and suggestions for further study.