The energy question

The so-called energy crisis that burst upon the world in 1973 was not easily understood by many people. It was neither 'the beginning of the end' nor the first encounter by modern man with the natural result of his prodigality. These papers, collected in two volumes, from energy economists in the United States, Canada, and Britain all indicate that the 'crisis' was and is a short-run problem caused by government action or inaction. The problem may be complex, but it was mishandled, particularly by the United States, in terms of government policy.

The rise in the price of, and the embargo on, oil came into being because of a successful producers' cartel outside North America; oil buyers – nations and companies – did not respond in kind but scurried around the world in separate planes in order to ensure supplies for themselves at any price. That price became many times the cost-of-production price, despite the fact that cool analysis reveals an increase in both production and reserves in most areas of the world. The shortages of refined oil products for consumers are attributable partly to the embargo, but also to a shortage of refineries and bottlenecks in transportation – some of which have been induced by government uncertainties over recent years. Proper government policies are now required.

The thirty-six papers in the two books treat a multitude of topics related to the question of energy as seen from the stance of the economist. All sources of energy are considered, as are the markets in major areas of the world; past policies are analysed, and future policies recommended.

It is hoped that the volumes, giving the background to the energy problems of the immediate future and a menu of prescriptions for their solution, will interest businessmen, market analysts, and policy-makers as well as economists, teaching or learning, in many parts of the world.

Volume 1 is titled *The World.*

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The energy question
An international failure of policy

VOLUME 2 NORTH AMERICA

UNIVERSITY OF TORONTO PRESS

Toronto and Buffalo

Volume 1
ISBN 0-8020-2134-4 (cloth)
ISBN 0-8020-6238-5 (paper)

Volume 2
ISBN 0-8020-2140-9 (cloth)
ISBN 0-8020-6240-7 (paper)

LC 73-91565

Printed in the United States of America

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Introduction

Both Canada and the United States are primarily fossil-fuel energy economies. In electrical generation, there is some use of hydro and nuclear power. But the electrical generation sector accounts for only about one-quarter of primary energy consumption (the other three sectors are transportation, residential, and commercial and industrial consumption); hydro and nuclear sources account in turn for varying fractions of the energy used in electrical generation, approximately 35 per cent in Canada and 25 per cent in the US; and potential new hydro sources are limited. Even if nuclear power begins to fulfill the promise that its advocates anticipate, atomic energy is apt to be a very junior partner in the overall North American energy supply and demand balance at the turn into the 21st century. At least for the lifetimes of most of the readers of these volumes, the North American energy economy is apt to remain based on fossil fuel.

Are we running out of fossil fuel? Of course, the world is running out of fossil fuel. The world is finite. But this does not mean that the world's economy is going to grind to a halt any time soon because we have used the last lump of coal, the last drop of oil, and the last whiff of natural gas.

Scare reports often assert that the US, Canada, North America, or the world only has x years of oil or gas reserves at current production rates (x is usually a relatively small number of years, say, 10 or 15). To put this into perspective, one must realize that, since we began to keep reserve statistics, the reserves-to-production ratio has always been a relatively small number of years. This is because proved reserves are like a grocer's shelf inventory. This inventory costs money to acquire. Just as a grocer does not carry unnecessary shelf inventory, the oil and gas industry does not intentionally engage in the premature develop-

ment of reserves. Production is a flow out of this inventory and discoveries are a flow into the inventory. Worldwide discoveries have been more than keeping pace with worldwide consumption. (See volume I of *The Energy Question*.)

For example, the real cost (what we have to give up in terms of labor and other resources to discover and develop oil) of oil has not sharply increased on a worldwide average. This may seem strange to say at this time when the world price of oil has been rising rapidly. But the world price increases have not been the result of real resource cost increases. They have been the result of the producer nations finding a way to combine their efforts and exercise substantial monopoly power.

For perspective, a comparison to flue-cured tobacco is appropriate here. For a long time the US enjoyed a monopoly on flue-cured tobacco. The basic power of monopoly is the power to withhold. The US monopoly on flue-cured tobacco has been enforced by production controls; had the US allowed unrestricted production of tobacco and free market sales, the price and cost of tobacco (net of rents) would have been lower. The same is true for oil. The recent worldwide price increases are a result of monopoly power exercised by the producing *countries* (not the companies) rather than real cost changes.

A similar proposition holds with respect to the political aspects of the Arab oil embargo. For years the United States has prohibited trade with Cuba because of US disagreements with Cuban foreign policy. Now, in the world oil market, the shoe is on the other foot.

The exercise of monopoly power by the major oil-exporting countries will have effects, however, on real costs in North America. Because the price of imported oil will be artificially high and its reliability doubtful, it will appear worthwhile to develop higher-cost US and Canadian reserves. The most prominent examples of these reserves are shale oil and tar sands oil. The shale oil is in the western United States; the tar sands are in Canada. At current world oil prices, development of these reserves is economically feasible. There are environmental problems which must be overcome, but the magnitudes of these reserves are stupendous. Together they total hundreds of billions, perhaps over a trillion, of barrels of oil. Together, with yet to be discovered and developed conventional oil and gas from Alaskan, Canadian, and US onshore and offshore sources, these reserves will last well into the 21st century. Coal reserves are also enormous.

LONG-RUN NORTH AMERICAN SUPPLIES OF CONVENTIONAL OIL AND NATURAL GAS

The most widely accepted estimates of the price elasticity of supply of North American crude oil discoveries is that it is about unity - a 1 per cent increase in

the price of oil results in about a 1 per cent increase in new discoveries. The price elasticity of supply of new natural gas discoveries may be higher than that for oil. In the long run, the elasticities of supply for discoveries are an approximation of the long-run supply elasticities for production. Before oil or gas can be produced, they must be discovered.

There are problems, however, with using such elasticity estimates for forecasting future discoveries and production. First, the level of future expected prices is apt to be far outside the range of prices which underlie the estimated elasticities. It is always dangerous to extrapolate functional relationships far beyond the data from which they were estimated. If the long-run price of oil stabilizes at, say, over $8 per barrel in the US, forecasts of discovery response based upon supply elasticities estimated from price data in the $2 to $4 range will be at best quite chancy. The same caveat applies to natural gas if deregulation is accomplished, ceilings are abolished, and field markets for production and reserves are allowed to clear at approximately double the wellhead price of recent years. Both prudence and cowardice cause us to be very reluctant to predict how much greater than 12 million barrels a day North American (combined US and Canadian) crude oil production will be in 1980.

This caution applies to both supply response at alternative prices and the level of prices themselves. There is no meaningful way to discuss the question of how much oil and gas we can ultimately expect to recover from the North American continent and its surrounding outer continental shelf except in the context of also specifying the price (and tax) climate in which drilling and production take place. The US real prices for crude oil and natural gas will be the North American reference prices against which the economics of other fuels and technologies must be evaluated. And, as in the past, the US prices will be policy variables. The higher are real prices, the larger will be the volumes of discoveries, proved reserves, production, and ultimate recovery. Also, the more rapid are any price rises and the more certain are oil and gas operators about their permanence, the larger and more rapid will be the supply responses. Beyond this, the policy uncertainties prevent us from being much more specific.

The second complicating factor is that existing onshore oil and gas production in the lower forty-eight states of the United States and in western Canada is typically in older petroleum areas. These areas have been relatively thoroughly drilled. The most attractive prospects have been tested. There is evidence that the exhaustion of potential drilling sites may shift the supply curve of discoveries back to the left at a rate of about 2 to 4 per cent or so per year. In the context of North America as a whole, this effect may be offset by activity in Alaska; the Canadian Arctic; the eastern, western and deeper areas of the Gulf of Mexico; the Alberta foot hills and northern British Columbia regions; offshore Newfound-

land and Nova Scotia; offshore California; and the US Atlantic outer continental shelf. But there is no sure proof of oil and gas other than the drillbit. Until there is an additional accumulation of operating experience, it would be foolhardy to hazard an exact adjustment based on speculation about these areas.

The third complicating factor involves the relationship between discoveries and production. There are four aspects of this problem which must be considered. They are all related to price. (1) At higher prices, it is economically worthwhile to shift production from the future to the present and perhaps to sacrifice some ultimate recovery. Thus, from a given discovery, there may be higher earlier production of shorter duration. This effect may be more than offset by three opposing forces. These are: (2) the incentives to be more aggressive in terms of extensions of existing and newly discovered reservoirs; (3) the incentives to use existing technology more intensively to increase the fraction of oil in place that is recovered through secondary and tertiary production techniques; and (4) the continuing development of new and improved recovery technology and reservoir engineering techniques. It is our judgment that the combined net effect of all four of the factors which affect the relation between discoveries and ultimate recovery will be to continue to shift the supply of ultimate recovery in year $(t + n)$ to the right for any discovery made in year t. But it is impossible to specify even an approximate magnitude for such an effect.

These three general areas of complicating factors are the reasons for our profound uneasiness with regard to forecasting future North American production. Our readers, however, deserve at least a guess. If the current world level of prices persists and the US and Canadian prices of crude oil are allowed to rise to that level, it is our judgment that North American conventional crude oil output in the 1980-85 period could be as much as 50 to 100 per cent higher than present levels. The elements of the lower end of this prediction are two million additional barrels a day from Alaska, two million additional barrels a day from extensive and intensive operations in new and existing offshore areas, two million additional barrels a day from onshore areas, and maintenance of the existing level of production. Even at the level of prices postulated, continued regulatory failures and their attendant uncertainties - together with a run of dry holes - could result in not achieving even the lower end of the range. Alternatively, major finds in Alaska and offshore areas alone could push total North American crude oil production through the top of the upper end of the range.

With regard to natural gas, Professors MacAvoy and Pindyck estimate that under a scenario of deregulation of US wellhead prices for natural gas, 1980 US natural gas production could equal approximately 33 trillion cubic feet at a real new contract field price of 65.5 cents per mcf. This is approximately a 50 per cent increase over current levels and is roughly consistent with alternative estimates

by Professors Spann and Erickson. It would appear likely under a similar scenario that annual Canadian natural gas production in the early 1980s might approximate 12 trillion cubic feet if it were freely competing in an integrated North American energy market at prices consistent with a netback from a real US price in the 65 cents per mcf or greater range and an optimal transportation network. These volumes might in turn be augmented by Alaskan gas reaching US and Canadian markets through a Mackenzie Valley pipeline.

The prospects for conventional North American oil and natural gas supplies for North American markets are not dim. They critically depend upon price and regulatory policy, but if the current level of world prices persists and is readily translated into incentives for US and Canadian production, supply response from conventional sources can be expected to be substantial.

PROSPECTS FOR TAR SANDS AND OIL SHALE

The largest known reserves of oil in the world are in the Canadian Athabasca tar sands and the US Rocky Mountain oil shales. This is not conventional oil in terms of the necessary means of production. Production is essentially a mining operation. Pilot plants have been built and used, but substantial operating experience is lacking. As with conventional oil, the volume of oil shale and tar sands reserves that is economically recoverable depends upon the price. The ultimate potential of these reserves of oil will depend upon the price and availability of alternative substitute sources of conventional crude oil - whether indigenous to the North American continent or from other areas.

Various trade press reports indicate that the capital costs for Canadian Athabascan tar sand oil are on the order of one billion dollars per 100,00 to 125,000 barrels per day of capacity. At a 15 per cent cost of capital and assuming a ten-year producing life for each increment of installed capacity, this works out to a capital cost of $4 to $5 per barrel of production. A 10 per cent cost of capital reduces the capital cost to about $3.50 to $4.25 per barrel of production. If operating and transportation costs are approximately equal to capital costs per barrel, tar sands oil is economically feasible at prices in the $8 to $10 per barrel range. (Based on current price expectations, lease bonuses in excess of $200 million have recently been paid for 5000 acre tracts of oil shale deposits.) These cost estimates are highly tentative and dependent over time on learning-curve experience, technological developments, environmental considerations, and the oil content and homogeneity of the deposits.

If the combined recoverable reserves of the tar sands and oil shale deposits total one trillion barrels of oil, and if the rate of growth of North American oil demand proceeds at 6 per cent per year, then these deposits alone would be sufficient to

supply *all* North American oil requirements until the year 2010. This calculation includes no oil from conventional sources and no imports from other areas. We have already discussed the potential of oil from conventional sources. The industry's interest in building superports suggests that an assumption of no available imports is unrealistic. Moreover, production from tar sands and oil shale is not now on stream and the start-up lead times would be substantial and in turn would extend the life of these reserves. Nevertheless, it is the availability of these reserves that makes the talk surrounding 'Project Independence' more than idle conversation.

In fact, there is a possibility for more than oil autarky. If the world price of oil holds, if aggressive development of oil shale and tar sands oil is undertaken, and if the more optimistic expectations for Alaska, Nova Scotia, Newfoundland, and the US Atlantic outer continental shelf are realized, it is possible that North America could become a net oil exporter to Japan and Europe in the 1980s. The law of joint probabilities, of course, makes such a development unlikely.

ENERGY AND THE ENVIRONMENT

The most critical long-run dimension of the 'energy crisis' is the intersection of energy and environmental policies. Both the production and consumption of energy have important environmental effects. Energy production problems are associated with strip mining, offshore drilling, refinery wastes, and tanker spills. Environmental problems associated with primary energy consumption include thermal and air pollution from electric power generation, automobile emissions, and industrial, residential, and commercial residual energy wastes.

The distinction between the long and the short run in the friction between environmental/economic/energy policies is important. In order to facilitate adjustment to the immediate dimensions of the energy crisis, environmental policy will have to accommodate energy policy. In the long run, energy policy can accommodate to environmental policy. Examples are air pollution standards for electrical generation, offshore drilling in the Atlantic, or superports. In the short run, it may be necessary temporarily to relax or postpone more stringent air pollution standards. This would allow coal to be burned (to the extent it is available in the short run) in many uses. In setting environmental standards for offshore drilling or superports, however, we are not dealing with such an immediate problem. This is not to say that decisions in these areas can be indefinitely delayed with no adverse effects on the energy situation. But the time horizons for these longer-term projects are such that if standards are determined and imposed, the energy companies can adjust to them in their planning.

Environmental protection will raise long-run costs. These increased costs must be borne ultimately by consumers of energy. But we use so much energy that, when the total environmental investment costs are spread over total energy use, the result will not be a skyhigh increase in unit energy costs from this reason alone. We are not facing a dramatic shift in the energy intensity of our society as a result of the costs of environmental safeguards. Proper planning must be done, but the focus of that planning will not be to gird ourselves for the apocalypse. Rather, it will be to solve in an orderly way the more mundane question of how much increases in the quality of the environment are worth in terms of increased cost in energy production and use.

LONG-RUN NORTH AMERICAN DEMAND FOR OIL AND NATURAL GAS

Recent growth in North American oil and natural gas demand has taken everyone by surprise. This especially is true of US oil demand. In 1968, US domestic oil demand (including exports, residual fuel oil, and petrochemical feedstocks) was 13.1 million barrels per day. In 1974, it is likely that US oil demand in the absence of supply restrictions would have been 18.7 million barrels per day (see Table 1). This is an increase of 43 per cent in six years, or a compound annual growth rate of over 6 per cent.

As a point of reference for comparative purposes, consider the demand estimates reported in *The Oil Import Question.*[1] The staff of the Cabinet Task Force on Oil Import Control reviewed all the demand forecasts and projections submitted to the task force by various companies and government agencies. The purpose was to arrive at a consensus estimate of what prospective US consumption experience was apt to be. No new and original estimations were conducted. The consensus compound growth rate was 3.1 per cent; projection of this rate implies 1974 consumption of 15.7 million barrels per day. The difference between projected 1974 consumption and actual 1974 consumption (unconstrained by embargo or other supply restrictions) is 3.0 million barrels per day – a difference of about 20 per cent. This difference goes a long way toward explaining the present shortage of US refining capacity and the pressure put on world oil prices by unanticipated US demand for refined products in the world market (see Table 2).

The consensus estimate of US demand in 1980 derived from submissions to the Cabinet Task Force was 18.6 million barrels per day. The 1980 estimates of Mobil and Exxon, for example, were 17.7 and 19.3 million barrels per day respectively. In 1973, US demand passed through 17.7 million barrels per day. In the absence

TABLE 1

US supply and demand for oil (millions of barrels per day)

	1973 Preliminary	1974 Preliminary pre-embargo	1974 Demand limited by supply
SUPPLY			
Domestic production			
Crude oil	9.2	9.0	9.2
Gas liquids	1.7	1.7	1.8
Total	10.9	10.7	11.0
Imports			
Crude oil	3.2	3.9	2.5
Residual	1.8	2.2	1.6
Other products	1.1	1.3	1.0
Total	6.3	7.4	5.1
Processing gain	.3	.5	.4
Total supply	17.4	18.7	16.4
DEMAND			
Gasoline	6.6	7.0	5.6
Aviation fuel	1.1	1.1	1.1
Distillate	3.2	3.6	4.0
Residual	2.7	3.2	2.9
Other products	3.4	3.7	2.4
Total domestic demand	17.1	18.5	16.0
Exports	.2	.2	.2
Total demand	17.3	18.7	16.2

SOURCE: *Oil and Gas Journal,* 'Review and Forecast Issue,' 28 January 1974, p. 109

of supply restrictions, US consumption would pass through 19.3 million barrels per day in 1975. The general underestimation of US demand growth should not be viewed as evidence of a conspiracy to mislead the Cabinet Task Force and other government policy-makers. The growth in US consumption over the decade prior to 1968 averaged only about 3 per cent per year. Government and non-industry analysts also underestimated the post-1968 growth in demand for oil.

What were the sources of the errors in the projections which led to such significant underestimation of US demand? Three major problem areas stand out.

TABLE 2

US imports

Crude imports by origin 1973 preliminary (thousand barrels per day)			Product imports, origin not traced 1964-73 (thousand barrels per day)	
Canada		998	1964	1060
Middle East			1965	1229
Saudi Arabia	445		1966	1348
Iran	191		1967	1409
Other	133	769	1968	1549
Africa			1969	1757
Nigeria	461		1970	2095
Algeria	140		1971	2245
Libya	148		1972	2532
Other	67	816	1973	2923
Latin America		428		
Far East		201		
TOTAL		3212		

SOURCE: *Oil and Gas Journal,* 'Review and Forecast Issue,' 28 January 1974, p. 118

First, and most important, the severity of the regulation-induced shortage of natural gas production and reserves has been greater than anticipated. The need for deregulation of the wellhead price of natural gas was apparent long before 1968. Nothing has as yet been accomplished. The resulting shortages of natural gas were translated into new demands for fuel oils.

Second, environmental restrictions shifted oil demand beyond its long-run growth curve. In response to clean air standards, many electric power generation facilities abandoned coal and shifted to fuel oil. The same shift occurred for some industrial energy uses. Automotive emission controls caused a substantial decrease in the gasoline mileage yielded by new autos. This decrease, while modest in each year, when accumulated over several model years of new automobiles caused a non-trivial change in the gasoline consumption characteristics of the automobile stock and a corresponding increase in oil demand.

Third, the US has been moving down the long-run demand curve for oil. This was a result of a secular trend of decreasing real oil prices. For example, the nominal price of gasoline in 1951 was 27.2 cents per gallon. In mid-1973, it was 40 cents per gallon. However, the consumer price index has increased from 77.8 to 135 over the 1951-73 period. Thus, the real price of gasoline has actually *de-*

creased by over 25 per cent. The price trends of fuel oils also involved real price declines. The result was that the growth in demand represented both a shift to the right in the demand curve and a movement down along the demand curve. Most analysts considered the price elasticity of demand for oil to be quite low. For example, estimates of the price elasticity of demand for oil contained in submissions to the Cabinet Task Force were on the order of -0.1.[2] That is, for an elasticity of -0.1, a 10 per cent decrease in price would result in a 1 per cent increase in consumption.

Long- and short-run fuel use decisions (for example, the trend toward heavier automobiles) were made on the basis of the real price behavior actually experienced. Recent evidence with regard to the switch to smaller cars, fuel conversion of electrical generating facilities, and decreased consumption of gasoline and fuel oil for space heating suggest three things. First, the long-run price elasticity of demand for oil is higher than had previously been believed. Second, the length of calendar time which distinguishes the long- from the short-run may be shorter than many had thought. And third, the cross-elasticity of demand between fuels may be higher than simple projections based on constant relative prices had anticipated.[3] The combined effect of these demand factors was to contribute to the acceleration of demand growth in the 1970s beyond the rate anticipated in projections based upon the experience up through 1968.

In addition to acceleration in the rate of growth of oil demand due to regulation-induced natural gas shortages, environmental factors and direct and cross price effects, other factors also played a part in increased US oil consumption. The most important other factor is the uncertainty with which the industry viewed the future. Because of indecision over an effective oil import policy, environmental pressures which limited some refinery capacity (see Table 3), and domestic price controls, the oil industry did not expand 'enough' in all areas - production, storage, and refining. Other important causes of the crisis include the failure of nuclear electrical generating equipment to be delivered on time or to perform at advertised efficiency levels, which resulted in reliance upon oil-fueled internal combustion turbines for baseload demand as well as peak-shaving service. In our opinion, the basic causes of the recent rapid US demand growth for oil have been the three major factors detailed above.

The crisis was not felt so strongly in Canada, even though imported oil is as important as in the US. Canada relies for some 10 per cent of its consumption on Mid East imports. In Table 4 we detail supply and demand balances for 1973 and a forecast for 1974. Canada, unlike the US, is self-sufficient in oil. The volume of oil exports exceeds the volume of oil imports. The embargo (which was or was not levied against Canada, depending on which producer was asked) affected mainly the area of Canada east of the Ottawa Valley (Quebec and the Maritimes).

TABLE 3

Preliminary list of refineries that have either been prevented or are being held up currently because of environmental considerations

Company	Site	bd
Shell Oil Company	Delaware Bay	150,000
Northeast Petroleum	Tiverton, RI	65,000
Steuart Petroleum Company	Piney Point, Md	100,000
Hampton Road Energy Co.	Norfolk, Va	180,000
Atlantic Richfield	Machiasport, Me	200,000
Metropolitan Petroleum Company (Pittston)	Eastport, Me	250,000
Fuels Desulfurization, Inc.	Riverhead, LI	200,000
Maine Clean Fuels	Searsport, Me	200,000
(Main Clean Fuels is a subsidiary of Fuels Desulfurization, Inc., and the refinery proposal at Searsport is the same proposal which was turned down at Riverhead, Long Island)		
Supermarine, Inc.	Hoboken, NJ	100,000

SOURCE: Office of Energy Advisor, Department of Treasury, memorandum by Douglas L. McCullough, Senior Staff Advisor, 27 August 1973; based on data from US Department of the Interior, Office of Oil and Gas.

In 1961, the federal Canadian government had decided that no oil imports be allowed west of the Ottawa Valley. Until 1973, Quebec and the Maritimes (which imported all their oil requirements) had the advantage of cheaper oil than Ontario, the province at the end of the domestic pipeline. The role is now reversed - a domestic price freeze west of the Ottawa Valley (at $4.10 per barrel of crude) has kept prices well below the levels in Quebec and the Maritimes. In order to lessen the impact on eastern Canada, the federal government has subsidized tanker shipments to the east coast via both the Panama Canal and the Great Lakes (volumes forecast to be 100,000 bd in 1974). The federal authorities have also proposed an extension of the domestic pipeline through Quebec and a subsidy to oil users in the east. Not wishing to extend the domestic price freeze to American purchasers of Canadian oil, the Canadian federal officials levied an export tax on crude oil, now amounting to $6.40 per barrel.

This combination of moves outraged the provinces with energy reserves and angered American officials. The resulting furor and one-up-manship games in Canada between the western provinces and Ottawa has no counterpart in the US. It would be difficult for an American to understand the underlying schisms in Canadian federalism, which oil and oil policy have brought into the open. The

TABLE 4

Canadian oil demand and supply balance (thousand barrels per day)

	Domestic production[1]			Exports			Domestic consumption	
	1973	1974		1973	1974		1973	1974
Alberta	1795	1823	US Dist I-IV	872	805	British Columbia	163	175
Saskatchewan	237	232	US Dist V	255	225	Prairies	242	250
British Columbia	64	64				Ontario	507	520
Manitoba	14	14				Eastern Canada	756[2]	780[3]
Other	5	5						
Total	2118	2137		1127	1030		1668	1725

Oil is defined as crude plus liquefied petroleum gases

1 includes 50,000 bd of synthetic crude from the tar sands

2 includes 14,000 bd of domestic crude

3 includes 100,000 bd of domestic crude

SOURCES: *Oilweek*, 18 February 1974; last column is authors' estimate.

basic question that Canadians are unable to resolve is to what extent the various parts of the country will share in oil profits.

There are both good and bad elements in Canadian policy, elements which should be of some lesson to Americans. First, Canadian governments did not introduce the formal allocation systems and restrictions on refinery outputs which characterize American policy. The absence of shortages of gasoline in eastern Canada show the overwhelming costs of US policies. We feel that the domestic price freeze in Canada is not of long-term benefit to Canadians - it encourages energy use and involves a subsidy to oil users, a subsidy which is not necessarily progressive. The decision to extend the domestic pipeline through Quebec and guarantee that market to western Canada will prove exceedingly costly, if, as we feel, world prices will fall. Ten dollars per barrel domestic oil in Quebec will not be a bargain if the world price is $5.

Canada did not have the environmental pressures to limit refinery capacity as was evident in the US. At the present time, projects adding one million bd to domestic refining capacity are currently under construction or planned. The Alyeska pipeline project which will involve supertankers passing close to the Canadian west coast stirs many visions of a *Torrey Canyon* type of spill, despoiling the fjords of British Columbia.

When the underlying economic situation is changing, projections of long-run demand can be seriously in error. Recent experience is ample evidence of this simple principle. Depending upon what assumptions are made with regard to direct and cross-price elasticities for various fuels, income elasticities, and trends in prices and incomes, nearly any projected time path of fuels demand can be generated. Our knowledge with regard to both the various elasticity coefficients and the exact (or even approximate) magnitudes of the likely time coefficients of the price trends is now very imprecise. It is a complicated and interrelated system that involves the supply and demand balances among alternative fuels and the effects of various regulatory and other public policies. One thing can, however, be said with certainty. If the long-run trend of North American real oil prices reverses itself and begins to rise, projections of North American oil demand based upon the experience of recent years will be much too high.

A NORTH AMERICAN ENERGY ECONOMY?

After the submission (and ultimately the rejection) of the Cabinet Task Force Report, one of the informal recommendations of the majority of the task force was that steps be taken to further coordinate and integrate US and Canadian energy policies. Some US steps were taken in this direction, but they were neither very vigorous nor pursued at a high enough level to be fruitful. US energy

policy-makers were too involved in pursuing the courses of action necessary to ensure the development of the trans-Alaska pipeline and the rise in Mid East oil prices to negotiate a common North American energy policy. But even had substantial efforts been made in this direction, it is not clear that success would have been easily achieved. Canadian energy policy is moving away from continentalism. There is moreover great fear of Americans. No evidence of this fear is more appropriate than present Canadian discussions of the route of the oil pipeline extension to Quebec. Canadians are reluctant to use the cheapest route, which runs through the US, because of fears, real or imaginary, of American takeover.

A simple but apt observation has been that the US would like access to Canadian resources on US terms and that Canada would like access to US markets on Canadian terms. This observation, of course, applies to any trade situation. Presumably the terms of trade can be worked out. The existence of substantial trade certainly suggests so. The new world oil market certainly creates ample incentives to do so. But in the process of negotiating the terms of trade for a North American energy economy, coherent domestic energy policies for both the US and Canada must be formulated. At the moment, Canadian and US friction with regard to energy policy between the two countries is only overshadowed by the discord within each country with regard to their respective domestic energy policies.

The catalogue of internal policy conflict within each country is strikingly similar. The items which are generating political heat (not to be confused with useful energy) include:

domestic price freezes,
tax policy,
formation of national energy companies,
tar sands and oil shale development,
pipeline policy,
the role of the federal government in energy policy vis-à-vis state and provincial governments,
the over-all level of energy prices,
access to foreign markets, and
the degree to which increased interdependence between the Canadian and US energy economies is desired.

The list is formidable. If each country must successfully resolve each policy problem in a mutually consistent manner, the prospect for an efficient allocation of North American energy resources does not appear bright. Successful policy formulation, however, is often a triumph of substance over form. Whatever institutional idiosyncracies are pursued and adopted in each country, the laws of supply and demand will still hold. The separate benefits of a more closely integrated

North American energy economy will make policy coordination mutually advantageous. In our opinion, the game is worth the candle. North American coordination of energy policy may be the vehicle for internal rationalization of both Canadian and US policies.

AN IMPENDING SENSE OF 'DÉJÀ VU'

There is, however, one stumbling block to the formulation of separate domestic and mutually coordinated North American policies. This is the relation between the North American energy economy and the world oil market. This juxtaposition has been a source of policy problems before. The Ottawa Valley Line and Mandatory Oil Import Controls are witness to that. In the light of recent high world oil prices and the Arab oil embargo, both of these 'solutions' to the problem of the relation between the world oil market and the North American energy market have been abandoned - at least temporarily. But, in the longer run there is little reason to believe that world oil prices are likely to remain higher than North American oil prices. This is particularly true if the United States actively pursues 'Project Independence' and if that policy involves coordination with Canada on a North American energy policy which involves substantial reliance upon oil shale and tar sands as crude oil sources.[4]

The trade news is full of evidence which suggests that the current situation is a transitory phenomenon. The *Wall Street Journal*, 22 February 1973, reports that Kuwait rejected as too low all 32 bids in its first oil auction. Part of the reason for the low bids may have been the absence of US demand at the auction.[5] Another reason may have been the short-run availability of other oil at lower prices from alternative sources. The long-run world oil supply situation looks optimistic (from a consuming-country point of view). A sample of recent news reports indicates substantial worldwide successful exploration activity, some evidence of a preference for auction sales of host country royalty oil, increased participation of governments in the oil trade, and an expanding legion of national oil companies such as the National Iranian Oil Company, Petromin, Kuwait National Petroleum Company, Iraq National Oil Company, Nigerian National Oil Company, Pertamina, and Venezuelan Petroleum Corporation. The prospect is for substantial downward pressure upon the world price of oil. Even Henry Kissinger may be unable to prevent the forces of the marketplace from operating.

If the United States pursues Project Independence, if the final version of Project Independence is a coordinated North American policy, and if Project Independence involves establishing North American real oil prices in a range whose upper end approaches approximately double the current levels - whether conventional crude oil or shale oil and tar sands oil are the marginal North American

supplies - then the most likely prospect is that some time before 1980 the world price of oil will begin to be below the North American price of oil by an increasingly large margin. The early 1980s would then produce a repeat performance of the late 1960s. The Cabinet Task Force on Oil Import Control will be replaced by a North American Energy Sufficiency Commission. Economic integration of the world energy market may assume a role in the world order of the late 20th and early 21st centuries similar to the role that political integration of the Balkans played in the late 18th and early 19th centuries. The challenge is to learn from our mistakes.

We hope that the eighteen papers presented in this volume will present sufficient data, history, and opinions for readers to pinpoint past mistakes and to see future policy options. Together with the papers in Volume I, sufficient information is provided, we trust, on the true nature of the crises: shortages of appropriate policies, not shortages of energy.

NOTES

1 The Report of the US Cabinet Task Force on Oil Import Control (Washington: GPO, 1970)
2 The distinction between long-run and short-run elasticities were not clearly established in the submissions. Nor were the bases indicated upon which the elasticity estimates were made.
3 For some preliminary econometric work on the problem of direct and cross-price elasticities, see E.W. Erickson, R.M. Spann, and R. Ciliano, *Fossil Fuel Demand* (Philadelphia: Decision Sciences, 1973), a report for the now disbanded Office of Science and Technology of the Executive Office of President, US Government.
4 Because of their high cost relative to inframarginal North American energy supplies, such as Alaskan oil or various natural gas sources, it may be appropriate to think of oil shale and tar sands oil as peak-shaving rather than base-load supplies.
5 See the editors' introduction to Volume I of *The Energy Question* for a discussion of the role of the US contribution to incremental world oil demand. The absence of demand for the US market by buying companies may have been a result of the US allocation system. Under the allocation system, crude oil supplies must be shared. There is no incentive to acquire additional crude oil which must be shared on the basis of the average price of all oil if the marginal price of the additional oil exceeds the average price. Although the evidence is limited and clouded by the special circumstances surrounding this

particular sale, the Arab-Israeli war, the oil embargo, and poor policy planning in the United States, it may be that the United States does have some elements of monopsony power in world oil markets.

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PART ONE

The United States

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EDWARD W. ERICKSON AND ROBERT M. SPANN

Energy policy involves a great many interactions with other policy areas. Some examples include the balance of payments, priorities with regard to social support of long-run research and development, environmental protection, foreign policy, and antitrust. These interactions can be very complex and it is desirable not to have, for example, the R&D policy tail wag the energy policy dog – or vice versa. This holds for all other policy combinations and formulations as well.

A particular example is antitrust. Many people realize that the energy crisis is a policy failure. It then becomes incumbent to find the policy that failed. If a single policy failure can be found that alone is sufficient, in the eye of the beholder, to explain our current unfortunate situation, then that relieves him of the necessity of examining all the perplexing policy interactions.

Perhaps because of the persistent strain of populism in the American psyche, an enduring single-barreled explanation is the classic charge of monopoly. Charges of effective collusion and conspiracy can be bent to fit any set of facts. And the evils of monopoly explain all ills.

Professors Erickson and Spann examine the US petroleum industry and conclude that it is effectively competitive. Their analysis centers on two recent charges of anti-competitiveness: excessive long-run profitability and collusion in offshore joint-bidding ventures. Professors Erickson and Spann do not here examine the structural characteristics of the industry. This is because of the large number of firms. By many counts, there are at least twenty major petroleum companies. In how many other industries is it possible to talk of the twenty major firms? Even if one adopts the Federal Trade Commission's

definition of eight major petroleum companies (as Professors Erickson and Spann do to simplify their analysis), in how many industries are eight major firms so approximately evenly matched and surrounded by so vigorous a competitive 'fringe'?

Erickson and Spann focus on long-run profitability. In 1973, the short-run profitability of the industry improved dramatically. This was primarily a result of the shortages resulting from the policy-induced energy crisis. For example, the profits of Exxon, the largest firm, increased nearly 100 per cent. But this did not lead the financial community to bid up the price of Exxon's common stock on the expectation that this increased profitability was an indication of a permanent change in the earnings capacity of the company based upon successful exploitation of newly found private monopoly power. Rather, by the end of 1973, the price of Exxon common stock had declined by about 20 per cent from its 1973 high. This response is consistent with expectations that the increasing earnings are transitory, not permanent. In fact, the price behavior of Exxon's common stock roughly parallels the overall performance of the general market for equities.

Professors Erickson and Spann do not take the issue of competition versus monopoly lightly. Since so many people attach so much importance to it, it must be taken seriously – particularly as a constraint on policy initiatives. But in their opinion, there is considerable danger that the formal and informal antitrust tail will wag the energy policy dog.

EDWARD W. ERICKSON AND ROBERT M. SPANN

The US petroleum industry

The United States has traditionally relied on free market forces and decentralized decision-making for solutions to resource allocation problems. The free market may not always solve resource allocation problems in a socially acceptable way: (*a*) when all costs and benefits are not internalized for the decentralized decision-makers responsible for production and consumption decisions; and/or (*b*) when the markets in question are not effectively competitive. Environmental questions are discussed elsewhere in these volumes. We focus here on some of the evidence regarding competition in the US petroleum industry.

COMPETITION IN THE US PETROLEUM INDUSTRY

Competition in the United States petroleum industry is an important topic in the policy discussions surrounding the current energy crisis. Concern over this subject runs the gamut from the marketing of gasoline through refining, pipelines, oil production, the field markets for natural gas, and the activities of traditional petroleum companies in other energy areas such as coal and nuclear power.

In our view, bigness is unfortunately confused with monopoly power. This confusion clouds the consideration of rational policy responses to the current energy crisis. The discussion of the competition issue generates a great deal of emotion on both sides of the question. It is too much to expect that we will be able to settle the issue here; it seems to be a permanent feature of political economics. We do, however, hope that we can illustrate convincingly with hard facts some of the reasons why, in our analytical judgment, the US petroleum industry is effectively competitive.

Our analysis centers upon two main areas. The first is the record of long-run profitability in the US petroleum industry. Profitability is an important index of the existence and exercise of market power. The petroleum industry is a large industry, and the firms within it are also large. Effective monopoly results in a divergence between long-run marginal costs and prices. Prices in excess of long-run marginal costs (including a competitive return on invested capital) result in excessive earnings. These excessive earnings are reflected in higher than normal, above average rates of return on stockholders' equity capital. Thus, the rate of return on corporate stockholders' equity capital is one measure of the presence or absence of market power in the petroleum industry.

The record of long-run profitability in the US petroleum industry indicates that the firms in this industry do not enjoy substantial, systematic market power. This index of effective competition yields positive results whether the comparison is to all US manufacturing, Moody's 125 Industrials, Moody's 24 Public Utilities, or a group of industrial firms known to possess market power, or the cost of equity capital for the petroleum industry.

The second area is the record of bidding for offshore acreage. This second area is particularly important for a number of reasons. First, a common practice in offshore bidding is for firms to enter joint bidding partnerships for particular tracts. It has been alleged that this practice is motivated by attempts at collusion rather than pooling of risks in a competitive economic environment. Second, offshore areas represent a very important component of new natural gas and crude oil supplies. It is important that we be satisfied that this significant portion of the industry is, in fact, effectively competitive. Third, a major cause of the current energy crisis is the cumulative effect of Federal Power Commission ceilings on the wellhead price of natural gas. This is a striking example of regulatory failure and regulation induced shortage. It appears that the only permanent solution to this problem is congressional action to deregulate the field markets for natural gas. [Editors' note: See the chapter on natural gas by Starratt and Spann.] But before this can be done, it must be demonstrated to Congress that these markets are effectively competitive. The offshore market is a prominent illustrative case. Our analysis indicates that the markets for offshore acreage and the output from productive offshore leases are effectively competitive.

INDUSTRY PROFITABILITY

Market power shows up as economic profits. The US petroleum industry has not earned the kind of long-run returns on stockholders' equity which are to be expected for firms that enjoy substantial, systematic market power. Recent profits of the petroleum industry have been much higher than the long-run average. This

TABLE 1

A comparison of rates of return on stockholders' equity between ten selected large firms in concentrated industries and the eight major petroleum companies[1]

Firm	Rate of return on stockholders' equity, 1972
General Motors	17.8
Xerox	23.4
IBM	18.7
Burroughs	15.4
Bristol-Myers	17.8
Eastman Kodak	20.4
Kellog	22.3
Proctor and Gamble	19.1
Pfizer	17.7
Eli Lilly	29.8
Ten company average	20.2
Average for eight major petroleum companies (1971)	11.1

is partly a result of the energy crisis and its attendant shortages. The energy crisis has been policy induced and is not a result of market power. Long-run profitability is the appropriate measure of competitiveness. Petroleum firms have had dramatic increases in profits in recent quarters. Two points must be made with regard to these profit increases. First, a substantial portion of petroleum firms' profit increases are the result of regulatory failures. The chief contributing factors were: (1) failure to relax mandatory oil import quotas in an orderly and expeditious fashion; (2) the regulation induced shortage of natural gas production and reserves; and (3) the subsequent effect of environmental controls to shift fuel demands to natural gas and to prolong the shortages of refinery capacity and refined products. Second, the recent percentage increases in profit performance of the industry have to be gauged against a normal base year, adjusted for inflation and compared to the profit performance of the general US economy. Even when these adjustments are made, there may still remain a transitory component which is the result of the energy crisis itself. In a well-functioning economy, these earnings would be the signals that would cause resources to flow into this industry and ultimately return profits to their long-run levels. For purposes of discussion of long-run policy responses, the appropriate measure of profitability is a long-run measure.

Table 1 compares the overall average profitability of the eight major petroleum companies named in the FTC complaint (see Table 3 for a listing of the companies)

TABLE 2
Comparison of rates of return

Year	Moody's 125 industrials	Eight largest petroleum firms
1971	11.2	11.1
1970	10.2	10.8
1969	12.2	10.8
1968	13.0	12.4
1967	12.4	12.4
1966	14.2	11.6
1965	13.7	12.1
1964	13.3	10.5
1963	12.4	11.5
1962	11.6	10.7
1961	10.5	10.4
1960	10.8	10.2
1959	11.6	9.8
1958	10.2	9.6
1957	13.2	13.1
1956	14.3	14.1
1955	15.4	13.7
1954	13.2	12.8
1953	13.4	13.9
1952	13.2	13.6
1951	14.6	15.3

with ten large industrial concerns generally conceded to possess some market power. The comparison indicates that each of the nonpetroleum firms earns more than the average for the eight major petroleum companies. The average for the ten nonpetroleum firms is 20.2 per cent. The average for the eight major petroleum companies is 11.1 per cent. The ten-company nonpetroleum average exceeds the average for the eight major petroleum companies by 9.1 percentage points, or 82 per cent.

Table 2 compares the rate of return on stockholders' equity for the eight major petroleum companies with the average for Moody's 125 industrials on a year-by-year basis from 1951 to 1971. In 16 of 21 years, the average for the eight major petroleum companies is less than that for the firms that make up Moody's 125 industrials. Moreover, in eight of the ten years covering 1962-71, the rate of return for the eight major petroleum companies was less than the return for Moody's 125 industrials. In one year, 1967, they were equal. In only one year, 1970, did the return for the eight major petroleum companies exceed that of Moody's 125

industrials – and then by only six-tenths of one percentage point, or 5.8 per cent.

In the eleven years prior to 1962, the rate of return for the eight major petroleum companies exceeded the rate of return for Moody's 125 in only three years. These were the consecutive years 1951, 1952, and 1953. On average then, the long-run trend over this period in the return on stockholders' equity for the eight major petroleum companies has been down relative to Moody's 125 industrials. This points up an interesting anomaly with regard to the use of concentration ratios. On the basis of concentration ratios and other data, the FTC has charged the eight major firms to be anti-competitive. Assuming that there are no errors in the FTC data, the concentration ratios do show an increase in concentration in the 1960s. But this is inconsistent with the profitability data. This highlights the difficulty of drawing inferences from gross concentration data alone and underlines the necessity of appropriately defining markets and the conditions of entry for those markets.

In the FTC complaint, rate-of-return data for the eight major petroleum companies are compared with rate-of-return data for all manufacturing. Table V-1 of the FTC Report is reproduced here as Table 3. Rate-of-return data are relevant to a discussion of whether or not the earnings of companies contain evidence of the exercise of monopoly power. In our judgment, a careful examination of the rates of return for the major oil companies does not indicate evidence of monopoly earnings. Instead, rate-of-return data indicate that the major oil companies earn a competitive rate of return. In addition, rate-of-return data indicate that the petroleum industry has been getting more competitive in recent years.

For the period 1961-71, on average, four of the eight major petroleum companies earned a lower rate of return on stockholders' equity than the average for all manufacturing industry. Four of the eight major petroleum companies earned more than the average for all manufacturing. Thus, the rate-of-return experience for the eight major petroleum companies has not been atypical with respect to all manufacturing. As with any average, some earn above the average and some earn below the average.

For the period 1961-71, on average, six of the eight major petroleum companies earned less on stockholders' equity than the average of Moody's 125 industrials. Two of the eight major petroleum companies earned more than the average for Moody's 125 industrials.

If the period is expanded to include the years 1951-71, there is evidence that the profits of the eight major petroleum companies were higher (relative to all manufacturing industry and Moody's 125 industrials) in the earlier years of 1951-60 than they were in the later years of 1961-71. For the years 1951-71, five of the eight major petroleum companies earned more on stockholders' equity

TABLE 3

Net income after taxes as a per cent of stockholders' equity for the eight largest integrated petroleum firms, 1951-71[1]

	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
Exxon	12.6	12.0	10.4	13.0	13.0	12.1	11.9	12.6	12.8	11.1
Mobil	11.2	10.6	10.1	10.5	10.0	9.7	9.2	8.8	8.6	8.2
Texaco	13.4	13.1	13.1	15.4	15.3	15.9	15.5	15.2	15.5	14.8
Gulf	10.2	10.4	12.1	13.2	13.1	12.3	11.2	11.0	10.9	10.6
Shell	8.7	8.7	10.9	12.3	13.8	13.4	13.4	12.3	12.0	11.2
Standard (Indiana)	9.6	9.3	10.0	10.1	9.5	9.1	8.1	7.5	7.3	6.6
ARCO	6.9	7.4	8.4	11.0	10.2	9.4	8.1	7.3	7.0	7.7
SOCAL	10.4	9.8	10.2	10.7	10.8	12.1	11.9	11.3	11.2	11.6
Weighted average	11.1	10.8	10.8	12.4	12.4	12.1	11.6	11.5	11.5	10.7
Return on equity in all manufacturing[2]	9.7	9.3	11.5	12.1	11.7	13.4	13.0	11.6	10.3	9.8
Net difference[3]	1.4	1.5	-0.7	0.3	0.7	-1.3	-1.4	-0.1	1.2	0.9

	1961	1960	1959	1958	1957	1956	1955	1954	1953	1952	1951
Exxon	10.4	10.1	9.4	8.7	14.0	15.8	15.2	13.6	16.2	16.6	18.4
Mobil	7.8	7.0	6.5	6.4	9.3	12.0	11.2	10.7	11.6	11.3	12.4
Texaco	14.4	14.3	14.1	13.6	16.2	16.3	15.7	14.8	13.7	13.6	14.6
Gulf	10.9	11.6	11.0	13.5	16.2	14.8	14.3	13.4	14.4	13.0	14.1
Shell	9.5	10.3	11.1	8.8	13.8	15.0	15.4	16.3	17.2	15.2	17.8
Standard (Indiana)	6.5	6.4	6.5	5.7	7.5	7.9	9.2	7.4	8.7	8.8	11.7
ARCO	8.1	8.6	5.8	6.8	7.4	10.1	9.0	9.6	12.2	10.7	12.6
SOCAL	11.7	11.8	12.0	13.0	15.5	15.8	15.1	15.3	15.0	15.0	16.2
Weighted average	10.4	10.2	9.8	9.6	13.1	14.1	13.7	12.8	13.9	13.6	15.3
Return on equity in all manufacturing[2]	8.9	9.2	10.4	8.6	10.9	12.3	12.6	9.9	10.5	10.3	12.1
Net difference[3]	1.5	1.0	-0.6	1.0	2.2	1.8	1.1	2.9	3.4	3.3	3.2

1 Based on 'Moody's Industrial Manual'

2 'Economic Report of the President,' January 1973, p. 280. The Federal Trade Commission is cited as the source.

3 Weighted average return for the 8 companies less that of all manufacturing

SOURCE: Table V-1 of the Federal Trade Commission Report, *Investigation of the Petroleum Industry* (Washington: Government Printing Office for the Permanent Subcommittee on Investigations of the Committee on Government Operations of the US Senate, 1973).

than the average for all manufacturing industry. Two earned less. For these same 1951-71 years, five of the eight major petroleum companies earned less on stockholders' equity than the average for Moody's 125 industrials. Three earned more.

Relative to the average for both all manufacturing and Moody's 125 industrials, the eight major petroleum companies were more profitable for the 1951-71 period than for the 1961-71 period. This could only occur if they were more profitable in the years 1951-60 than in the years 1961-71. Profitability has been decreasing. To the extent that decreased long-run profitability is an index of increased competition, the profitability indices indicate that the petroleum industry has been becoming more rather than less competitive. (This indication is consistent with, for example, the record of entry into offshore activity.)

Comparison to averages such as Moody's 125 industrials and all manufacturing industry may be misleading. This is because some of the nonpetroleum firms in these averages may possess market power (see, for example, Table 1). This makes the averages themselves higher than the normal, long-run, competitive rate of return. There is a way to correct for this.[2] A standard procedure in regulatory proceedings is to calculate the cost of equity capital for the particular firm(s) in question. Earnings on equity capital are then compared to the cost of equity capital.

Modern analysts typically calculate a range for the cost of equity capital. This is because a range is more reliable than a point estimate. Using standard techniques for the years 1967-71, the range for the cost of equity capital for the eight major petroleum companies is 10.3 to 12.3 per cent.[3] The midpoint of this range is 11.3 per cent.

For this same 1967-71 period, the average earnings on stockholders' equity for the eight major petroleum companies were 11.5 per cent. Within the limits of the precision of such calculations, the earnings on stockholders' equity (11.5 per cent) and the cost of equity capital (11.3 per cent) are approximately equal. This is what we would expect in an effectively competitive industry operating in an economy with well-functioning capital markets. The rate-of-return data indicate that the eight major petroleum companies are part of a competitive industry and are themselves earning the competitive rate of return. If simple monopoly power or more complex collusive behavior were an important feature for the petroleum industry, one would expect it to show up in the rate-of-return data. It does not.

The rate-of-return data examined here do not indicate that the petroleum industry has been competitive in all times or in all places. It is well known that some of the classic American antitrust cases involve the petroleum industry. One of the costs of maintaining a competitive economy is constant surveillance by the antitrust agencies. But the recent rate-of-return data do indicate that this surveillance has paid off – at least with respect to the petroleum industry.

There is another possible difficulty with regard to rate-of-return analysis when it is applied to large, integrated companies operating in several distinct markets. This possible difficulty is that the companies may have monopoly power in some markets, but not in others. In such a case, monpoly earnings in some markets may be used to subsidize less than competitive earnings in other markets. The effect could then be an overall rate of return on equity capital equal to the cost of equity capital with monopoly earnings in some markets submerged in the overall average. (Such a situation leaves unanswered the question of why a company not regulated on a rate base, fair rate-of-return standard would persist in operating in a market in which it was earning less than the competitive rate of return. We pose this question, but do not consider it further.) A market in question is the offshore Gulf of Mexico area. An important component of domestic oil and gas supplies is the offshore area in the Gulf of Mexico. Nearly 20 per cent of US total natural gas and crude oil production comes from this offshore area, which will be even more important in the future. Fortunately, a good deal of data exist which allow the application of rate-of-return analysis to the offshore area in the Gulf of Mexico.

OFFSHORE LEASE SALES

It has been charged that joint bidding ventures in offshore lease sales are evidence of a collusive pattern in the petroleum industry which escapes the surveillance of the antitrust authorities. This charge is inconsistent with the record of profitability for the industry (both on offshore activity and in aggregate) and the actual pattern of bidding behavior. The evidence is consistent with the proposition that the industry is in general effectively competitive - and particularly so with regard to offshore activity.

In our opinion, joint bidding is a vehicle for pooling risks involved in offshore operations and serves as a vehicle which enhances entry into offshore activity by relatively smaller firms. This opinion is consistent with an analysis of offshore lease sales by Professor Jesse W. Markham.[4] Markham found that there was no statistical evidence that joint bidding reduces the number of bidders and that joint bidding is not inconsistent with an increase in the number of bidders and the average bid.

This evidence is also consistent with a more detailed analysis of the actual bidding patterns and the rate of return on assets committed to offshore activity. We have analysed the record of bid patterns for joint ventures.

The patterns for winning bids are summarized in Tables 4, 5, and 6. These tables show percentage bids in each category that were made by firms or groups of firms which contained no representatives of the eight major petroleum companies.

TABLE 4

Joint venture bidding patterns for winning bids, 1954-73 sales

Number of firms in combine	Number of bids	Per cent nonmajors
1	1121	49
2	356	24
3	145	43
4	206	46
5 and over	69	77
Overall	1897	44

TABLE 5

Joint venture bidding patterns for winning bids, 1973 sale

Number of firms in combine	Number of bids	Per cent nonmajors
1	11	36
2	14	71
3	10	80
4	38	87
5 and over	31	74
Overall	104	75

TABLE 6

Joint venture bidding patterns for winning bids, 1972 sales

Number of firms in combine	Number of bids	Per cent nonmajors
1	63	60
2	52	27
3	39	41
4	24	25
5 and over	14	50
Overall	192	42

As Table 4 indicates, approximately half of the winning bids were made by single firms or combinations of firms which included no representative of the eight majors. In addition, almost half of the single-firm winning bids were made by nonmajor firms. This evidence is not consistent with a situation in which the major firms are able to enforce collusive bidding arrangements as a result of their participation in joint bidding ventures.

Tables 5 and 6 confirm the results of Table 4. In 1972, 42 per cent of all winning bids were made by nonmajor firms and 60 per cent of winning single-firm bids were made by nonmajor firms. In 1973, 75 per cent of all winning bids were made by nonmajor firms and 36 per cent of all winning single-firm bids were made by nonmajors. This is not evidence of collusive bidding patterns.

When Tables 5 and 6 are combined and compared with Table 4, an interesting result emerges. In the combined 1972 and 1973 lease sales, 54 per cent of all winning bids were made by single firms or combines which included no majors. This compares to the equivalent figure for all 1954-73 lease sales of 44 per cent. Also, in the combined 1972-3 lease sales, 57 per cent of all single-firm winning bids were made by nonmajor firms. This compares to the equivalent figure for 1954-73 lease sales of 49 per cent.

These comparisons indicate that for a large number of firms entry is possible into offshore activity, that joint bidding is not always necessary for such entry but that it is a facilitating factor, and that entry has occurred over the 1954-73 period. (These conclusions are also supported by a similar analysis of second and third place bids.)

Out of a total of 776 joint ventures which submitted winning bids, only 91 (or 12 per cent) consisted of majors alone. But 295 (or 38 per cent) consisted of nonmajors only. One-half of all joint ventures consisted of both majors and nonmajors, but the turnover in bidding partnerships was significant. There were no winning combines in excess of three firms which consisted only of majors. These data are a very strong indication that offshore activity is undertaken in a very competitive economic environment.

THE RATE OF RETURN TO OFFSHORE ACTIVITY

If the lines of argument developed in the two previous sections are correct, the rate of return to resources committed to offshore activity should be equal to the competitive rate of return. This can be tested. In order to determine if the rates of return in the Gulf of Mexico offshore area are competitive and typical of the competitive rate of return earned by the petroleum industry, we analysed the available data. This financial and economic analysis included lease bonuses, so it

is also relevant to the question of 'collusive joint bidding combines.' There is one methodological difference between the offshore rate-of-return analysis and the eight major company average analysis reported above. First, the rates of return are computed on total assets. This is because it is impossible to break out the equity capital components on a disaggregated basis. This difference is adjusted for and does not affect the conclusions. Second, in addition to discussing retrospective rates of return, we analysed prospective rates of return of the three very recent lease sales. This analysis involved computing competitive lease bids on the basis of a discounted cash flow model. These results are discussed below. The prospective analysis also required estimating future oil and gas prices. These price assumptions are also discussed below.

There have been a number of studies of the rate of return on investment expenditures for offshore exploration, development, and production. These studies conclude that the rate of return for offshore activity is approximately equal to the competitive rate of return on investment in the American economy. These findings are consistent with the conclusions of staff studies for the Cabinet Task Force on Oil Import Control.

One of the recent studies was done by L.K. Weaver and associates of the Bureau of Mines.[5] This was a very detailed engineering-economics study of a typical, successful 5000 acre offshore tract in the Gulf of Mexico. The Weaver study indicated that the rate of return on total assets committed varied between 14 and 17 per cent - depending on the rate of withdrawal of the oil and gas. The Weaver study, however, was for a successful tract. Not all tracts are successful. For example, only 40 per cent of the tracts leased in 1970 have resulted in commercially feasible production. Some of the currently unproductive tracts may yet become producers, but the effect of unproductive acreage is to reduce the rate of return toward the competitive rate.

An estimate of prospective profitability at the time of a lease sale is of more interest for the problem at hand than a study of retrospective profitability. The data underlying the Weaver study are very complete and amenable to adjustment to reflect economic conditions at the time of the 1972 and 1973 lease sales. We have adjusted the Weaver data on the basis of the 1972-3 economic situation. Investment decisions are based on forecasts of future prices and costs. Our adjustments included: (i) increasing geophysical, platform, and drilling costs to current rates, and (ii) assuming oil prices of $5 a barrel and gas prices of 65 cents per mcf. These prices, particularly the oil price, would not be relevant for a lease sale to be held now. This is because there has been a revolution in expected prices. Prices for new oil are in the over $6 a barrel range. Controls, embargos, and regulatory paralysis have so muddied the water that it is very difficult to quantify price expectations at this time. For oil, they are certainly higher than $5 a barrel.

For natural gas from the federal offshore areas, there is no telling. Overall, realized average hydrocarbon prices will likely be higher than the expected prices upon which lease bids were made. This will create windfall profits. [Editors' note: See the Millsaps, Spann, and Erickson chapter on tax policy for a more complete discussion of this problem. An excess profits tax for the petroleum industry has recently been proposed. Not only is such a tax complicated to administer, but it does not provide a permanent solution to the fundamental problems discussed by Millsaps, *et al.*] But the existence of possible windfall profits does not change the relevance of the calculations reported here.[6] For the purposes of these calculations, the relevant prices are the expected prices at the time the bids were made. Reasonable estimates of expected prices for the 1972 and 1973 lease sales are $5 a barrel and 65 cents per mcf. These are the prices used here.

The expected price and adjusted cost data were combined with the relevant tax parameters, a rate of return on total assets of eight per cent, and Weaver's estimated reserve data to build a discounted cash flow model which takes into account the fact that in an overall offshore exploration campaign not all tracts are successful. This model was then used to predict bonus bids per acre for the 1972 and 1973 lease sales. The predicted bids were then compared with actual bids as an indicator of the competitiveness of both offshore production activity and the bidding process.

The test of competitiveness is the relation between predicted and observed bids. If predicted bids exceed observed bids, then this is an indication that the Federal Treasury is not capturing all the rents from offshore tracts. If observed bids are approximately equal to or exceed predicted bids, then this is an indication that a competitive bidding process is at work. This is a straightforward test, but it must be applied to a number of lease sales. Just as is the case of a computation of the cost of equity capital, a range of data which includes some of the variation from lease sale to lease sale is more reliable. Also, this is a single test and its results must be considered jointly with other available evidence. The bidding process actually generated winning bids per acre for the 1972 and 1973 lease sales as follows: 19 December 1972, $4,108 per acre; 12 September 1972, $2,017 per acre; and 19 June 1973, $2,908 per acre. The average predicted bid for the three lease sales equaled roughly $2500 per acre. The observed bid for the three lease sales equaled roughly $2700 per acre. The observed average bid slightly exceeds the predicted average bid.

The bidding evidence suggests that the offshore leasing process is highly competitive and that rents resulting from the unit cost advantages of offshore areas are captured by society at large in the form of payments to the Federal Treasury. This behavioral evidence is consistent with the structural evidence from concen-

tration ratios and the performance evidence from the analysis of overall industry profitability.

The evidence indicates that oil and gas companies earn no more than a competitive rate of return on offshore activity. Lease bids for individual 5000 acre tracts may be as high as $100 million. In the Alaskan lease sale, the total bonus payments approximated one billion dollars. These aggressive bids occur regardless of whether firms are bidding in joint ventures to pool risks or bidding individually. Presumably the companies are not indifferent to sums of this order of magnitude.

If the companies could be sure to be successful in the acquisition of acreage by bidding smaller amounts, they would do so. But competition makes this impossible. Joint bidding ventures are unsuccessful as a mechanism for obtaining an essential, specialized resource on noncompetitive terms. This evidence, together with the long-run profit performance of the industry, and the patterns of lease bidding combinations, indicates that joint bidding ventures are similarly ineffective in creating noncompetitive conditions in the sale of oil and gas.

The evidence from the offshore bidding data is especially important for public policy formation with regard to natural gas field markets. It indicates that higher supply prices for new natural gas supplies are the result of the higher costs of securing those supplies. It is true that offshore areas are quite important in current production, and even more important in terms of prospective production. But offshore areas still account for a minority fraction of total production (relative to onshore areas) and will do so for the balance of this decade. It is also true that offshore areas have lower unit costs (net of bonus payments) than do onshore areas. In light of this, two questions may be asked, 'What do offshore costs, including bonuses, have to do with onshore costs?; and, with respect especially to natural gas, why should we allow prices to rise on offshore natural gas if those price increases will simply be captured by the Federal Treasury as increased bonus payments?'

There are several points which should be made with regard to these questions.

(a) Offshore costs including bonuses are a reasonable proxy for onshore costs. If the companies could discover and produce onshore gas at lower costs than the costs (including bonuses) for offshore gas, and sell it in intrastate markets, they would do so. The basic economics of maximizing profits by equating at the margin indicates that the unit costs of incremental onshore new gas supplies must be in the neighborhood of those for offshore gas.

(b) Not all offshore tracts are successful and commercially feasible. Higher prices for offshore gas will make some tracts that are not now productive commercially feasible and will also stimulate more intensive drilling. The net effect of this will be to increase offshore areas' gas supplies that will be available to the interstate market. We need all the gas we can get.

(c) Artifically holding offshore gas prices down to a level below that of the best substitute - onshore gas - will encourage waste in consumption. Prices will lag further behind opportunity costs and aggravate the existing shortage. A significant part of the current shortage is demand induced. In addition to finding ways to stimulate supply, public policy should also cause available supplies to be rationed among the highest valued uses. The price system is the most efficient rationing system we know. A way to both stimulate new supply and conserve our scarce gas resources by allocating them to their highest valued use is to allow market clearing prices to operate.

Thus the data from offshore bidding are instructive on two counts. First they are consistent with the overall picture of the domestic petroleum industry as an effectively competitive industry. In this connection, setting maximum prices in the field markets for natural gas cannot be justified on the basis of protecting consumers from monopoly power. Rather, maximum prices merely deprive consumers of gas that they desire and result in willy-nilly income redistribution among various users of alternative fuels. Second, the offshore bidding data indicate that a *prospective*, cost-based, regulated wellhead price in the field markets for natural gas in 1972 and 1973 would have been on the order of 65 cents per mcf. Since the actual ceiling price on new gas was only about one-half of that, it is not surprising that the shortage of production and reserves began to take hold with a vengeance. The lesson is clear. *Ad hoc* tampering with competitive markets eventually results in serious dislocations. The same is apt to be true for other segments of the industry.

COMPETITION, MONOPOLY, AND POLITICAL POWER

Although we believe that the petroleum industry is in general effectively competitive, this does not mean that it is not without substantial political power. Political power is different from market power. This is as true in petroleum as it is in agriculture. Industry political power may change the economic environment in which the whole industry operates, but not the long-run profitability of individual firms. Evidence of the political power of the industry can be found in the historical record of market demand prorationing, mandatory import quotas, and other federal policy (the Connally 'Hot Oil' Act, for example) which supported the prorationing system and the depletion allowance and related tax provisions. But the industry is not omnipotent. Witness the continued ceiling price on natural gas and the reduction in percentage depletion. Moreover, even when the industry is successful at creating some advantage, resources flow and the benefits are competed away. The result is that in the long run - which is often