
NATURAL RESOURCES JOURNAL

Volume 23
Issue 4 *Fall 1983*

Fall 1983

The Structure of International Steam Coal Markets

David S. Abbey

Charles D. Kolstad

DAVID S. ABBEY and CHARLES D. KOLSTAD*

The Structure of International Steam Coal Markets

A common view is that the international coal market is reasonably competitive and that prices will tend towards long-run marginal costs. However, analyses of many commodities reveal the importance of market imperfections and market power in explaining price formation and trade flows. A review of the structure of the steam coal market suggests the market is not perfectly competitive. Considering industrial concentration, market shares and government policy, it is possible to identify participants with the potential to exercise market power. These include the Republic of South Africa, Australia, and Poland on the supply side and Japan and the European Community on the demand side.

I. INTRODUCTION

Rising prices for oil and gas over the past decade have led to increased worldwide demand for steam coal, which in turn has increased international steam coal trade. Two basic applied economics problems arise in examining commodity trade, including coal. First, what are the determinants of trade flows and market shares for various producing and consuming countries? A second problem, which in some sense is an extension of the first, concerns forecasting future trade and the effects of government policies on trade. The United States, for example, is anxious to do as much as possible to enhance its coal export prospects. Addressing these problems requires an understanding of how coal markets are structured, what market power can be wielded by participants, and what factors enter into production and consumption decisions.

The conventional wisdom is that the international coal market is competitive by virtue of abundant endowment and wide distribution of coal resources, and large numbers of consuming and importing nations. For example, the annual report of IEA Coal Research (a unit of Great Britain's National Coal Board) suggests that:

> There is sufficient free competition in and between the four major exporting countries [Australia, Canada, South Africa and the United States] for the price of coal to tend towards long run marginal cost.[1]

*Economics Group, Los Alamos National Laboratory and Department of Economics, University of Illinois. Work sponsored by U.S. Department of Energy and conducted while both authors were with the Economics Group of the Los Alamos National Laboratory in New Mexico.

1. IEA COAL RESEARCH, 1981 ANNUAL REPORT 8 (1981).

However, market analyses of many other comodities traded internationally—notably crude oil and grain—reveal the inadequacy of the perfect competition market model in explaining trade patterns.[2]

Perfect competition requires complete information, free entry and exit of firms, and sufficient numbers of buyers and sellers so that individual actions don't affect prices. However, as a consequence of concentration of buyers and sellers or government intervention, the exercise of power to influence commodity trade flows and prices is not uncommon. The objective of this paper is to analyze the international steam coal market in order to infer market conduct which in turn determines price levels and trade patterns.

The analysis progresses in three stages. First, we review basic conditions and structure of the steam coal market to determine which actors—national governments, state traders, or private firms—are capable of wielding market power. We address five aspects of the market: (a) geographical structure of supply, demand and transportation (including quality of coal resources, resources by mining type, and access to deepwater ports); (b) concentration among producers and consumers; (c) barriers to entry; (d) the structure of demand; and (e) government trade policies (including formal economic blocs, preferred trading relations, and export and import quotas).

We conclude that potential power in steam coal trade rests with a number of different actors: the European Economic Community and Japan, by virtue of dominance in import demand; the Republic of South Africa, due to low FOB-port coal costs, a domestic producer cartel, and a system of export licenses and quotas; Australia, owing to low FOB port coal costs, export controls, and a relatively concentrated steam coal export industry; and Poland, through the force of a state monopoly and close proximity to European markets. One might also include multi-national corporations (MNCs), considering their superior technical capabilities and access to information concerning energy markets. Admittedly, this is no exclusive club. One might argue it is so large as to render any concept of power to set prices meaningless. However, we offer some historic examples of the exercise of market power in coal trade that suggest otherwise.

The second stage of the analysis is a qualitative description of the conduct of the actors in the steam coal market. First, we hypothesize the objectives of the various actors (e.g., to maximize short-run profits or export earnings). Then we consider strategies the actors might pursue in

2. *See* McCalla, *Structural and Market Power Considerations in Imperfect Agricultural Markets*, in IMPERFECT MARKETS IN AGRICULTURAL TRADE 9 (1981); and Radetzki, *Market Structure and Bargaining Power: A Study of Three International Mineral Markets*, 6 RESOURCES POLICY 115 (1978).

a multilateral framework—that is, when each actor with market power is trying to anticipate actions and reactions of competitors. This qualitative approach provides some insight into alternative models of price formation; however, it is inconclusive by definition.

Finally, we provide a brief review of conventional market models of imperfect competition—for example, various models of oligopoly and oligopsony, producer cartels, and so forth—in an effort to match one such model with the observed market structure. Through this three step process we develop a framework for quantitative analysis of the international steam coal market.

II. BASIC MARKET CONDITIONS AND STRUCTURE

By way of introduction we present some background information on international coal use. Table I reports coal production and consumption by country in 1980. Not surprisingly, consumption is concentrated heavily in the industrial nations. The United States, the Soviet Union, and China account for 55 percent of world consumption. These nations, with Poland and the United Kingdom, account for nearly two-thirds of world consumption. Most of the major consuming nations produce their domestic requirements with the notable exceptions of France, East Germany, and Japan. Considering the bulk of coal, the relatively high proportion of transportation costs in delivered costs, and the widespread global distribution of coal resources, the reliance on domestic supply is not surprising.

In 1980 trade of metallurgical and steam coal accounted for only 331 million standard tons[3] (about 11 percent of consumption). Historically, much of world coal trade has been overland trade to neighboring countries—for example, from the western Soviet Union to eastern Europe, Poland to western Europe, and the United States to Canada (see Fig. 1). While little international data is available that distinguishes trade flows by coal types, metallurgical coal, not steam coal, has clearly dominated trade.

One can make three broad judgments on the outlook for the international coal market.[4] First, considering forecasts of steel output and technological change, trade of metallurgical coal is likely to stagnate or decline. Second, since delivered prices of steam coal to Europe and Japan are about half the energy equivalent price of crude oil or natural gas, rapid growth in steam coal demand is possible. Such growth depends on the future of oil prices and nuclear power—coal's major competition for electricity generation. Third, coal production in many industrialized nations will stag-

3. As used in this report, a standard ton of coal is 25,190,000 Btu.

4. *See generally* M. GASKIN, MARKET ASPECTS OF AN EXPANSION OF THE INTERNATIONAL STEAM COAL MARKET (IEA Coal Research, 1981).

TABLE I.

1980 Coal Production, Consumption and Exports for Major Producing and Consuming Nations[a]

	Production (10^6 short tons)	*Apparent Consumption (10^6 stc)*	*Exports (10^6 stc)*
United States	830	614	97
Canada	40	34	18
Other America	24	30	—
West Germany	239	140	22
France	23	57	1
United Kingdom	141	126	7
Other Western Europe	140	150	5
USSR	790	504	38
Poland	254	190	40
Czechoslovakia	136	73	7
East Germany	285	96	2
Bulgaria	32	25	—
Hungary	28	16	—
Romania	39	27	—
South Africa	127	84	30
Australia	140	78	51
China	684	582	5
India	125	88	—
Japan	20	98	3
North Korea	50	50	—
Other	51	54	10
	4,198	3,116	331

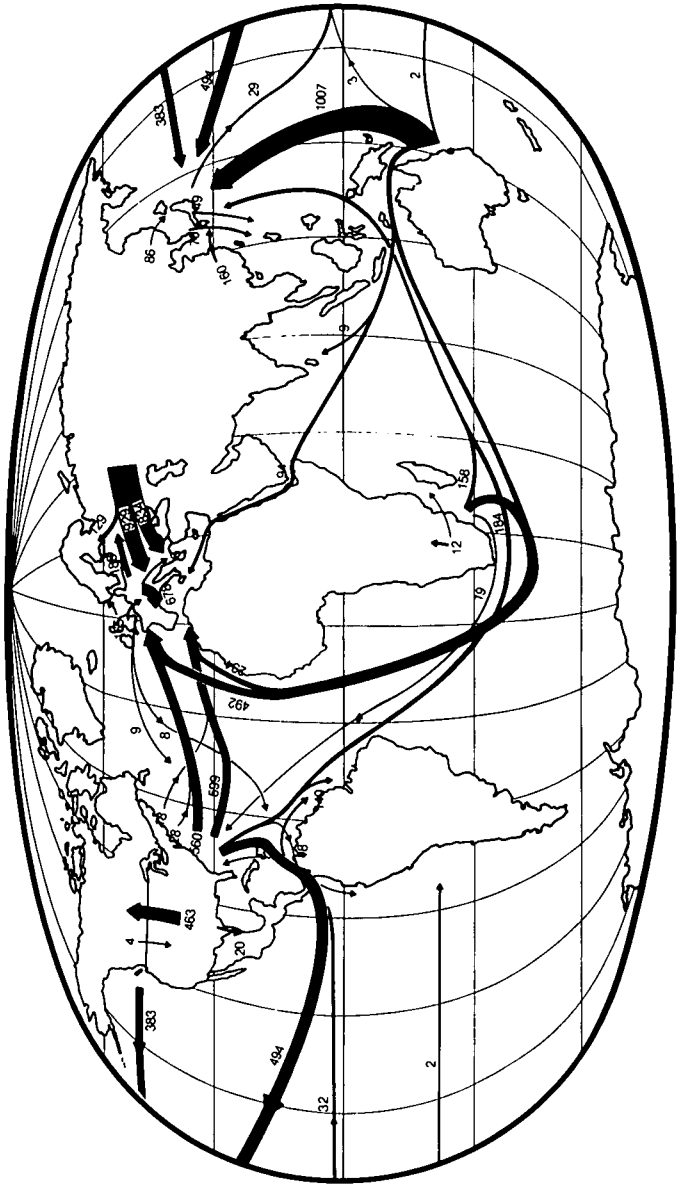
[a]Countries with less than 25 units of consumption or production are listed in Other. Units are either short tons or standard tons of coal (1 stc = 25,190,000 Btu).

Source: U.S. DEPARTMENT OF ENERGY, 1981 INTERNATIONAL ENERGY ANNUAL 181 (EIA-0219, 1982).

nate or decline, principally because depletion leads to higher mining costs. The Netherlands abandoned production in the early 1970s. France, the United Kingdom, and West Germany heavily subsidize their domestic industries through direct payment, import quotas, or purchasing requirements placed on utilities. In short, rapid growth in steam coal trade seems likely. To determine which countries will benefit from trade, we next consider the spatial distribution of supply and demand.

A. Geographical Structure of Supply and Demand

The logical criteria for screening the most favored export countries are quantity and quality of resources and transportation costs to the dominant



Source: U.S. DEPARTMENT OF ENERGY, 1981 INTERNATIONAL ENERGY ANNUAL 79 (EIA-0219[81], September 1982).

FIGURE 1. International coal flow 1980 (trillion [10^{12}] Btu).

TABLE II.

Estimated World Coal Reserves
(10^6 stc)

	Recoverable Reserves[a]	*Percent World Total*	*Total Resources*[b]	*Percent World Total*
USSR	109,900	17.3	4,860,000	48.0
United States	177,588	27.9	2,570,398	25.4
People's Republic of China	98,883	15.5	1,438,045	14.2
Australia	27,353	4.3	262;134	2.6
Federal Republic of Germany	34,419	5.4	246,800	2.4
United Kingdom	45,000	7.1	163,576	1.6
Poland	21,790	3.4	124,000	1.2
Canada	9,381	1.5	115,352	1.1
India	33,700	5.3	56,799	0.6
South Africa	26,903	4.2	57,566	0.6
Other	52,012	8.1	231,834	2.3
World Total	636,929	100.00	10,126,504	100.0

[a]Amount of reserves in place that can be recovered under present local economic conditions using available technology.

[b]Total amount available in the earth that can be successfully exploited and used by man within the foreseeable future.

Source: World Energy Conference Survey of Energy Resources, 1977, cited in NATIONAL COAL ASSOCIATION, INTERNATIONAL COAL: 1978 I-1 (1979).

import markets in the industrialized nations of Europe and East Asia. Table II shows estimated recoverable reserves and resources by country. The Soviet Union, China, and the United States possess 60 percent of recoverable reserves and 85 percent of resources. However, these endowments are less important than mine production and especially transportation costs, because coal resources are so abundant. For example, Botswana's reserves of hard coal—3.5 billion standard tons of coal which appear in the "Other" category of Table II—are sufficient for more than a year of world consumption.

1. Resource Quality. With respect to coal quality, sulfur content less than 1.5 percent is a standard specification of internationally traded coal, calculated to meet environmental standards and obviate the installation of flue gas desulfurization equipment. Specification of heating value is typically over 10,000 Btu/lb and preferably in the range of 11,000–13,000 Btu/lb (in other words, bituminous coal). Lower quality coal serves domestic markets.

What accounts for the disinterest in sub-bituminous coal in the international market? Consider first the situation of a country with a large

domestic coal market relative to export demand (such as the United States). Assume a simple competitive model with one source of supply of bituminous and sub-bituminous coal and one point of consumption. Assume further that domestic delivered energy cost (for example, $\$/10^6$ Btu) is the sole determinant of the price differential between bituminous and sub-bituminous coal. The costs of acquiring each coal type (measured in thermal units) tend to equalize:

$$(P_s + t)/\alpha_s = (P_b + t)/\alpha_b , \tag{1}$$

where α_i is the heat content of coal i, t is the unit cost of transportation, and P_b and P_s are the mine-mouth prices of bituminous and sub-bituminous coal.

Suppose a new source of demand develops in a more distant (export) market served at unit transport cost, T ($T > t$). If export demand is small in relation to domestic demand, or more precisely, if the export demand has no effect on domestic prices, then, as shown by Equation 2, sub-bituminous or lower quality coal will not be used in the export market, since in equilibrium it will appear to be more costly than bituminous coal:

$$(P_s + T)/\alpha_s > (P_b + T)/\alpha_b . \tag{2}$$

This suggests that if a large domestic market exists, prices of sub-bituminous coal will be set by domestic demand in such a way that the coal cannot compete with bituminous coal in distant markets.

Now consider the case where export demand determines mine-mouth prices. Transportation costs require a minimum price differential between bituminous and sub-bituminous coals. Equation 3 shows the value P_s/P_b for which Equation 2 is an equality:

$$\frac{P_s}{P_b} = \frac{\alpha_s}{\alpha_b} - \frac{T}{P_b}\left(1 - \frac{\alpha_s}{\alpha_b}\right) . \tag{3}$$

In interpreting this equation, consider first the case of mine-mouth consumption ($T = 0$). In such a case the ratio of mine-mouth coal prices is precisely the ratio of heating values for the two coals. However, the larger the ratio T/P_b, the larger the price penalty of low-grade coal. For Australia and the Republic of South Africa to Japan, the ratio T/P_b is about 0.5. Assuming heating values of 9,000 Btu/1b for sub-bituminous and 12,000 for Btu/lb for bituminous coal, the sub-bituminous coal supplier would receive at best a mine-mouth price about 60 percent that of the bituminous producer.

This analysis can extend to a comparison of countries competing to supply coal. For a developing country, such as Chile, that is a potential supplier of low-quality coal, the ratio T/P_b is likely to be greater, making the price outlook even more bleak. Finally, when one considers that boiler

TABLE III.

Selected January 1982 Spot International Steam Coal and Shipping Prices (averaged, U.S. 1981 dollars/ton)

	Price FOB Port	*Ocean Freight*[a]	*Delivered Price*
U.S. east coast to NW Europe	$59.50	9	68.50
Poland to Italy	64.50	8	72.50
South Africa to Europe	55.00	11	66.00
Australia to Europe	60.50	15	75.50
U.S. east coast to Japan	59.50	21	80.50
South Africa to Japan	55.00	10	65.00
Australia to Japan	60.50	9	69.50

[a]This freight cost does not include demurrage charges (for ships waiting to load), which can be significant.

Source: *Coal Week International*, January 20 and February 10, 1982.

equipment, flue gas cleaning, and solid waste disposal costs also increase with lower quality coals, one understands the near-exclusive interest in bituminous coal in the international market.

Several factors determine the competitive position of bituminous coal suppliers: the method of extraction (surface or underground); proximity of coal fields to demand centers and ports; and the extent of existing transportation infrastructure (rail line capacity, port loading capacity, and port depth). The infrastructure criterion places new entrants to the international market, especially developing countries, at substantial disadvantage. In the remainder of this section, we provide brief characterizations of the leading exporters.[5]

2. Spatial Distribution. Tables III and IV present estimates of steam coal costs and delivered prices to Europe and Japan from the major exporting nations. It is important to realize that Table III reflects prices whereas Table IV is an estimate of costs. Single time-point delivered prices are not necessarily indicative of competitive advantage because of price volatility (for example, in ocean charter rates), and especially because FOB port prices are not necessarily representative of marginal costs. Nevertheless, it is apparent from Table IV that Poland and the Republic of South Africa have a great advantage in the European markets, and

5. For more thorough country reviews, *see* R. GREENE & J. GALLAGHER, FUTURE COAL PROSPECTS: COUNTRY AND REGIONAL ASSESSMENTS (1980); ICF, INC., COAL RESERVES AND PRODUCTION IN EIGHT MAJOR, NON-U.S. COAL PRODUCING COUNTRIES (1978); and ICF, INC., COAL SUPPLY CURVES FOR AUSTRALIA, CANADA, AND SOUTH AFRICA (1980).

TABLE IV.

Indicative Steam Coal Costs[a]
(1979 U.S. $/ton)

	Price FOB Mine	*Mine to Port*	*Price FOB Port*	*Port Loading*	*Ocean Freight*	*Port Unloading*	*Delivered Price Range*	*Avg.*	*$/MBtu*
TO: NW Europe									
FROM:									
United States									
East—Underground	22–39	11–17	33–50	1–2	7–11	2	43–65	54	1.85
West—Surface	9–20	11–22	22–39	1–2	9–12	2	34–55	45	2.19
Canada									
West—Surface	17–22	11–20	28–39	1	9–12	2	40–55	46	1.92
Australia									
Underground	17–28	6–11	22–28	2	11–15	2	37–47	43	1.63
Surface	13–22	6–11	20–28	2	11–15	2	35–47	42	1.52
South Africa									
Underground	11–17	6– 8	17–24	1	9–11	2	29–39	34	1.41
Poland									
Underground			25–34	1	6	2	34–43	39	1.46
TO: Japan									
FROM:									
United States									
East—Underground	22–39	11–17	33–50	1–2	12–17	2	48–70	59	2.05
West—Surface	9–20	11–22	22–39	1–2	10–13	1	34–55	44	2.00
Canada									
West—Surface	17–22	11–22	28–39	1	8	1	39–50	44	2.00
Australia									
Underground	17–28	6–11	22–28	2	7– 9	1	32–40	36	1.38
Surface	13–22	6–11	20–28	2	7– 9	1	30–40	35	1.33
South Africa									
Underground	11–17	6– 8	17–24	1	10	1	29–36	33	1.36
Poland									
Underground			25–34	1	12–14	1	40–48	44	1.67

[a]Costs may not correspond to prices.

Source: U.S. DEPARTMENT OF ENERGY, COAL EXPORT STUDY 9 (1979) cited in C. WILSON, COAL: BRIDGE TO THE FUTURE 126 (Ballinger, 1980).

Australia and the Republic of South Africa have the lead in the Pacific Rim markets. Poland, of course, can deliver cheaply by rail to eastern European countries, and from Gdansk (with a 100,000-dwt vessel capacity)[6] and other ports to western Europe.

The coal fields of Transvaal in the Republic of South Africa are several hundred miles by rail from the principal port at Richards Bay, which presently accommodates 160,000 dwt super-colliers. Dredging plans exist to accommodate 250,000 dwt colliers. More importantly, mine production costs are exceptionally low. A U.S. coal industry analyst estimates South African mine-mouth costs at $14.80/ton and rail and loading costs at about $10/ton.[7] Considering the representative FOB port price of $50/ton shown in Table III, these costs imply an incredible profit at the mine of $26/ton.

Australia has vast bituminous coal fields within 100 miles of existing ports in Queensland and New South Wales. Almost all Queensland production is by surface mining methods. New South Wales production is about 75 percent underground. Hay Point, the largest port, can accommodate 135,000 dwt colliers. Other ports—Gladstone, Newcastle, Port Kembla, and Sydney—which are presently in the 60,000 dwt class, are being deepened to accommodate vessels in excess of 100,000 dwt.[8]

Those Canadian coal fields with potential in the export market occur in the Rocky Mountains region of Alberta and British Columbia. Rugged terrain and faulted, steeply dipping seams make extraction of some resources quite difficult and expensive. Elsewhere, however, potential exists for surface mining, with some seams up to twenty feet thick.[9] Transportation distances are about 700 miles to existing ports (with capacity greater than 150,000 dwt) in the Vancouver area.

Western U.S. coal reserves are mostly sub-bituminous. The bituminous reserves in Utah, Colorado, New Mexico, and Wyoming are roughly 1,000 miles from the Pacific coast ports, which presently lack the capacity to handle large volumes of coal. On the east coast, the Appalachian coal fields are within several hundred miles of ports at Norfolk and Baltimore. In 1981, the U.S. coal industry had well over 100 million tons per year (MT/yr) excess capacity.[10] Existing U.S. rail capacity is adequate to handle increased coal traffic, and, after a few difficult years, the ports seem to have adapted shipping terminals to the handling of steam coal.

6. Dwt = Dead weight tons, a measure of vessel capacity. Larger capacity vessels usually have a larger draft requiring deeper ports.

7. Price, *The Coal Observer Treks to South Africa*, COAL OBSERVER 12 (Feb. 1981).

8. AUSTRALIA DEP'T. OF TRADE AND RESOURCES, AUSTRALIA'S MINERAL RESOURCES: STEAMING COAL 8,9 (1980).

9. ICF, INC. (1980), *supra* note 5, at 3–13.

10. U.S. DEP'T. OF ENERGY, COAL PRODUCTION—1981 74 (1982).

A major problem in the eastern United States, aside from relatively high production costs, is that harbors are limited to colliers in the Panamax class (less than 60,000–70,000 dwt). Port dredging from current depths of 40 feet to 60 feet or more is quite expensive and faces budget authorization battles and lengthy permit reviews.

The Soviet Union probably will not be an important factor in the world market for steam coal.[11] Only six percent of Soviet reserves are in eastern Europe where coal fields are heavily depleted.[12] In the Donets Basin, for example, which contributes about 30 percent of Soviet output, the average working depth is below 500 metres and 80 percent of the seams are less than one metre thick. More remote Soviet fields in the Arctic and Asia suffer from severe climatic conditions, making extraction and transportation difficult and expensive. The Sourth Yakutia basin in the far East currently supplies coking coal and a small amount of steam coal to Japan (the contract calls for 85 million tons over about 20 years), but Pacific ports are about 1,500 miles away by rail. (Slurry pipelines may provide a promising transportation alternative.)

A few developing countries have potential to enter the export market before the year 2000—Colombia, China, Indonesia, and perhaps India. However, for these countries more than for existing producers, port proximity is vital. Coal export development typically involves not only new mine construction as in industrialized countries, but new port and rail construction. Furthermore, one may expect limited opportunities for economies in freight cost through the handling of other commodities. Botswana is occasionally mentioned as a potential exporter. Certainly Botswana has substantial strippable coal resources, but getting coal to Walvis Bay in Namibia requires 1,000 miles of railroad construction across the Kalahari Desert.[13]

B. Concentration

The question of concentration concerns the number of producing and consuming firms in importing and exporting countries, the role and number of trading companies, and the market shares of trading countries.

1. Number of Firms by Country. There are many steam coal producers worldwide, although there is considerable range in producer competition within individual exporting countries. For example, coal ownership, production, and trading is by state monopoly in Poland. In developing coun-

11. *See generally* U.S. OFFICE OF TECHNOLOGY ASSESSMENT, TECHNOLOGY AND SOVIET ENERGY AVAILABILITY (1981); and U.S. CENTRAL INTELLIGENCE AGENCY, USSR: COAL INDUSTRY PROBLEMS AND PROSPECTS (1980).

12. U.S. OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 11, at 84–86.

13. Swersey, Emergent Coal Suppliers to the Atlantic Basin, available from the author at Exxon Minerals Co., New York (1981).

TABLE V.

South African Export Allocations by Exporter (1981)

Exporter	Annual Maximum Export Allocation (10^6 tons/yr)	Annual Maximum Export Allocation (cumulative fraction)
TCOA[a]	12	0.27
GENCOR	7.5	0.44
Amcoal	6	0.58
Shell	5.5	0.70
BP	5.5	0.83
Rand Mines	2.5	0.89
Antracite Producers Association	2.5	0.94
Total (France)	2.5	1.00
	44.0	

[a]Includes 2 Mt/yr allocation to Natal Assoc. Collieries, which is managed by the TCOA.
[b]Selling organization for Amcoal, Graham Beck, and Duiker Exploration.

Source: Ellis, COAL, GOLD, AND BASE MINERALS OF SOUTHERN AFRICA 93 98 (June, 1981).

tries, coal ownership is typically by state monopoly, though production and trading rights may be leased or assigned to joint-venture partners. In the United States, there are hundreds of producers. Because of the more limited number of producers in Australia and the Republic of South Africa, as well as their cost advantages noted above, these countries warrant special attention.

The South African coal mining scene is complicated by the presence of domestic price controls and export licenses. Nonetheless, a high degree of industrial concentration is evident. Collieries operated by six mining houses—Anglo-American Corporation (Amcoal), General Mining Union Corporation (GENCOR), Barlow Rand (Rand Mines), Johannesburg Consolidated Investment Co., Lonhro South Africa, and Gold Fields of South Africa—accounted for 92 percent of 1979 coal production.[14] All six are members of the Transvaal Coal Owners Association (TCOA), whose function is to assign production quotas and market and distribute member output.[15] The TCOA is also the principal owner of the export terminal at Richards Bay. Table V shows export allocations under phase III of the export development program (to be achieved by the mid-1980s). Allocations to the TCOA and individual TCOA members, totaling 28 Mt/yr, represent 63 percent of current export allocations. Three multinational

14. *Cooperation Leads to Efficient Marketing*, 1/2 MINING SURVEY 43 (1981).

15. *See* Ellis, *Coal Export—Staking Out the Issues*, 29 COAL, GOLD, AND BASE MINERALS OF SOUTH AFRICA 93 (1981); and MINING SURVEY, *supra* note 14, at 53.

energy companies—Shell, BP, and Total—have most of the remaining export allocations. They obtain coal from joint-venture projects with South African firms.[16]

Australia has a history of concentration in the coal industry.[17] With rapid growth in the Austrialian export market and the possibility of minority foreign investment, one might expect increased competition. A government compiled inventory lists 40 corporate ventures into the steam coal export market.[18] Yet, examination of this inventory reveals considerable corporate interlocking in joint ventures and suggests a pattern of concentration in Australian development that may be representative of concentration in the world market.[19]

Consider the kinds of firms involved in Australian coal export projects.[20] Domestic ownership is strongly represented by large mining houses (for example, BHP, Peko-Wallsend, and MIM), and other conglomerates (CSR and White Industries). Multinational corporations engaged in resource extraction have purchased major stakes in Australian coal firms or have active Australian subsidiaries. For example, Rio Tinto Zinc of England controls CRA, Ltd.; British Petroleum purchased Clutha in 1978; Shell owns 37 percent of Austen and Butta and 45 percent of Bellambi Coal Company; and Arco owns 32.5 percent of R. W. Miller and 38 percent of Blair Athol. Finally, many of the projects involve investment by coal importers, notably the general trading companies of Japan—Mitsui, Marubeni, Mitsubishi, and C. Itoh; foreign coal consumers (for example, the Electric Power Development Company of Japan); and foreign coal producers (for example, the French production monopoly, Charbonnages de France).

In Table VI we report, by firm, potential 1990 Australian steam coal exports from projects currently in production or planned for development. Four firms account for 38 percent, eight firms for 60 percent, and 16 firms for 80 percent of potential 1990 exports. When one considers intercorporate linking and communication through joint venture arrangements or interlocking directorates, the potential for oligopoly in Australian steam coal exports seems greater. For example CSR, the leading firm with 15 percent of 1990 export potential, is involved in 23 percent (on

16. *Coal Survey,* Financial Mail, August 14, 1982, at 24.

17. H. SADLER, ENERGY IN AUSTRALIA: POLITICS AND ECONOMICS 104–111 (1981).

18. *See* AUSTRALIA DEP'T. OF TRADE AND RESOURCES, AUSTRALIAN COAL EXPORT PROJECTS (1981).

19. Ownership patterns in Australia are in a state of flux. In 1976 the Australian government outlined requirements for a minimum of 50% Australian-owned equity in most natural resource projects including coal. The Foreign Investment Review Board has applied these guidelines flexibly and Australian ownership is increasing, but the issues surrounding foreign ownership remain controversial. *See Australian Economic Survey,* 278 ECONOMIST 22 (October 31, 1981).

20. *See generally:* AUSTRALIA DEP'T. OF INDUSTRY AND COMMERCE, MAJOR MANUFACTURING AND MINING INVESTMENT PROJECTS (1981).

TABLE VI.

Concentration in the Australian Steam Coal Export Market—
Projects for 1990 Production

Firm	*No. of projects*[a]	*1990 export potential*[a] *(10^6 t/y)*	*Cumulative fraction of 1990 export potential*[a,b]	
			A	*B*
CSR	10	19.7	0.15	0.23
Shell	7	11.7	0.23	0.37
BHP	4	10.1	0.31	0.46
MIM	4	9.2	0.38	0.49
White	1	8.4	0.44	0.59
Marathon Pet. Austr.	1	8.0	0.50	0.65
British Petroleum	2	7.2	0.55	0.73
Mitsubishi	6	6.6	0.60	0.76
Howard Smith	3	6.0	0.64	0.89
CRA Ltd.	2	4.7	0.68	0.89
Elec. Comm. of NSW	2	3.6	0.71	0.95
Oakbridge Inds.	1	3.0	0.73	0.95
Arco	2	2.7	0.75	0.95
Peko Wallsend	2	2.6	0.77	0.95
Amax	1	2.3	0.78	0.95
Australian Mutual Prov. Society	6	2.1	0.80	0.96
Other	Not available	27.0	1.00	1.00
Total	40	134.9		

[a]Steam coal projects currently in production or planned for development. Excludes projects with 1990 potential less than 1 Mt/y. In joint ventures, output is apportioned to firms based on ownership.

[b]The difference between Column A and B has to do with accounting for output from joint ventures. In Column A, output is apportioned to firms based on the fraction of ownership or participation in a joint venture. In Column B, the entire output of a project is associated with the highest ranking participant.

Sources: DEPARTMENT OF TRADE AND MINERAL RESOURCES, AUSTRALIAN COAL EXPORT PROJECTS (1981); DEPARTMENT OF INDUSTRY AND COMMERCE, MAJOR MANUFACTURING AND MINING INVESTMENT PROJECTS (June 1981).

a tonnage basis) of the projects. Projects including at least one of the four leading firms reported in Table VI—CSR, Shell, BHP and MIM—account for 49 percent of 1990 export potential. Projects including at least one of the leading eight firms account for 76 percent of export potential. Referring to the United States, where relatively strict controls on interfirm cooperation and communication exist, Scherer states that:

> When the leading four firms control 40 percent or more of total output, it is fair to assume that oligopoly is beginning to rear its head.[21]

The 1990 steam coal export potential listed in Table VI exceeds 130 Mt/yr. Considering that 1980 Australian steam coal exports were under 10 Mt/yr (see Table VII), one might suspect that many of the projects will not come to fruition. The point is that the structure of Australian industry—concentration among suppliers and buyers and vertical and horizontal integration—may influence the price and export market share of Australian steam coal.

On the importing side,there is a worldwide trend to centralized national coal purchasing.[22] The classic example is L'Association Technique de L'Importation de Charbonniere (ATIC), the French coal importing monopsony. Japan and Spain formed state corporations to coordinate coal imports and investigate overseas development projects. In Italy, South Korea, and Taiwan, national electric companies dominate import demand with minimal competition if not cooperation from industrial importers (especially the cement industry). In Belgium, Denmark, and the Netherlands, utilities and other users have formed voluntary cooperatives to purchase steam coal. Of the major importers, Germany alone is characterized by fragmentary coal purchasing.

2. Market Shares by Country. There is no consistent source of steam coal trade data with which to evaluate market shares by country. In Table VII we present estimates of steam coal exports excluding intra-Communist bloc trade. In 1979, Poland and the Republic of South Africa (with a state trading monopoly and domestic cartel, respectively) accounted for approximately 60 percent of total exports listed. In 1980, Poland, the Republic of South Africa, Australia, and the United States accounted for virtually all exports listed.

To evaluate market shares of importing nations, we consider Australian government forecasts of steam coal imports for 1985 and 1990 (Table VIII). Those forecasts, based on a country-by-country examination of electric utility capacity expansion and coal conversion plans, provide a

21. F. SCHERER, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 67 (1981).

22. *See generally* GASKIN, *supra* note 4.

TABLE VII.

Estimated Steam Coal Exports
(10^6 tons/yr)

Country	*1979*	*1980*
Australia[1]	6.2	9.9
Canada[2]	1.0	1.3
RSA[3]	16.7	22.5
U.S.[4]	14.1	26.8
(U.S. excluding Canada[4, a])	2.5	16.0
Poland[4, a]	20.5	16.6
China[4, b]	0.3	0.6
UK[5, c]	2.4	4.0
USSR	NA	NA
Other	NA	NA
	61.2	81.7

[a]Exports to West only.
[b]Calculated from Japanese steam coal imports.
[c]Total exports; the annual report of the National Coal Board suggests that exports were mostly for "steam raising."

Sources: (1) INTERNATIONAL COAL REVIEW 4 (May 12, 1982); (2) personal communication, Canadian Embassy in Washington; (3) COAL, GOLD AND BASE MINERALS IN SOUTHERN AFRICA 96 (June 1981); (4) COAL INDUSTRY QUARTERLY (Merril Lynch, December, 1981); (5) personal communication, British Information Services, Washington, D.C.

consistent, although probably optimistic, short- to mid-term projection. In east Asia, Japan dominates with about 50 percent of import demand in 1985 and over 40 percent of demand in 1990. In western Europe, no country alone is dominant. France accounts for 30 percent of projected 1985 import demand, but only 15 percent of 1990 demand because of an agressive nuclear program. Germany is the leader in 1990 with under 20 percent of import demand. The ten countries of the European Economic Community, however, account for almost 90 percent of 1985 import demand and almost 80 percent of 1990 demand in western Europe.

In this section, we have evaluated concentration of coal producers and consumers (number of firms and market shares) by country. We also noted that the role of trading companies or market intermediaries is relevant to market concentration. Rather than considering the role of such companies explicity, we advance to the next element of the structural analysis, barriers to entry. Evaluation of barriers to entry suggests the importance of vertical and horizontal integration in coal trade and the market power of multi-national corporations.

TABLE VIII.

Projected Steam Coal Import Demand (10^6 tons/yr)

	1980 (actual, est.)	*1985*	*1990*
East Asia			
Japan	8	25–29	39–52
South Korea (ROK)	—	9–11	18–21
Taiwan	6	7–8	15–20
Hong Kong	2	4–6	10–13
Other Asia (8 countries)	—	1–8	7–20
	15	46–61	88–125
Western Europe			
Belgium/Luxembourg	6	7–8	8–11
Denmark	11	15–17	17–20
West Germany (FRG)	9	9–15	20–39
France	22	25–33	18–29
Italy	6	7–11	14–26
Netherlands	4	7–8	12–15
Spain	1	11–14	15–19
Other Europe (8 countries)	8	9–21	23–24
	66	89–127	127–193
Middle East (3 countries)	1	0–4	6–10
Latin America (4 countries)	1	1–4	1–9
Total	83	136–196	231–337

Source: AUSTRALIA DEPARTMENT OF TRADE AND RESOURCES, COAL DEMAND STUDY (June 1981): from country analyses of utility conversion and expansion plans and demand and conversion in other industries, especially cement.

C. Barriers to Entry

Three important barriers to entry are relevant to the international coal market: financial resources (export development projects may involve multi-billion dollar investments), technical capability, and market information. These barriers are particularly effective against the solo entry into the market of developing countries with attractive resources (Colombia, China, and Indonesia), resource owning firms with little production experience (e.g., White Industries in Australia), and coal producing firms with little experience in the international market. At the same time, these barriers provide a market opportunity to multi-national corporations (MNCs). In fact, much of the literature on MNCs attributes to them two

important functions: reducing the costs of "arms-length" transactions (finding buyers and sellers, conducting negotiations, writing complete contracts), and increasing factor mobility (transferring technical and commercial "know-how" and capital).[23]

Vertical and horizontal integration typically characterize the activities of MNCs. The general trading companies in Japan provide the best example of vertical integration in coal trade. Reportedly, 65 percent of Japan's large industrial company sector revolves around six industrial groups (Mitsui, Mitsubishi, Marubeni, C. Itoh, Sumitomo Shoji, and Nissho Iwai).[24] The general trading company establishes corporate policy and links the resource development, importing, processing, and marketing activities of subsidiaries and affiliates. Although we have limited information concerning the activities of these general trading companies in the international coal market, the *Economist* reports a tendency for the Japanese companies to bargain jointly with coking coal producers in Australia.[25]

Some state coal and electricity production companies also have direct foreign investments. Spain's Carboex recently purchased a 10 percent share in Ashland Oil's coal unit. The purchase entitles Carboex to a steady supply (0.8–1 Mt/yr) at "preferential prices."[26] The Italian government's AGIP is a joint venture partner in an Australian mine.[27]

A firm producing a similar product in different countries represents horizontal integration. Thus, in the international coal market one sees mining houses (for example, Rio Tinto Zinc, Anglo-American, and GE's Utah International) and oil companies (for example, Arco, Shell, BP, and Exxon) producing and investing in Canada, Australia, the Republic of South Africa, the United States, and developing countries.

The entry of MNCs into the international coal market tends to increase efficiency of economic activity; however, questions remain as to how the market power of MNCs influences competition. While there is a long history of MNC involvement in mining projects in developing countries, it is worthwhile to consider a case study of the decisions leading to an agreement between the Colombian state company, Carbocol, and Intercor,

23. *See, e.g.*, Caves, *International Corporations: The Industrial Economics of Foreign Investment*, 38 ECONOMICA 1 (1971); Agmon & Hirsch, *Multinational Corporations and the Developing Economies: Potential Gains in a World of Imperfect Markets and Uncertainty*, 41 OXFORD BULL. OF ECON. & STAT. 333 (1979); and Teece, *The Multinational Enterprise: Market Failure and Market Power Considerations*, 22 SLOAN MGMT. REV. 3 (1981).

24. Helou, *Sogo Soshas and Japan's Foreign Economic Relations*, 13 J. WLD. TRADE LAW 257, 261 (1979).

25. ECONOMIST, *supra* note 19, at 15.

26. *Spain Authorizes Firm to Purchase 10% Stake in Unit of Ashland Oil*, Wall St. J., March 9 1982, at 27.

27. AUSTRALIA DEP'T. OF INDUSTRY AND COMMERCE, *supra* note 20.

a subsidiary of Exxon, to develop the northern area of El Cerrejon as an export project.[28]

In the mid 1970s, Colombia's state oil company, ECOPETROL, and a state industrial development institute, IFI, were competing for the rights to develop El Cerrejon. In early 1976, the Ministry of Mines requested development bids for El Cerrejon. In November 1976, Carbocol was created with 49 percent ownership by ECOPETROL, 40 percent by IFI, and 11 percent by other parts of the Ministry of Mines. In December 1976, Carbocol signed a joint-venture agreement with Intercor providing equal sharing of investment costs and production, a 15 percent royalty of Intercor production to the government, and for Intercor to operate the project.

In his study of the project, Kline makes several important observations: first, ECOPETROL and Exxon had a history of cooperation in the oil industry; second, there was little public debate about the type of contract to be used at El Cerrejon; third, the final contract is silent about the amount of production; and fourth, there are concerns about the transfer pricing practices of Intercor as the operator of the mine, the railroad, and the port.[29] Kline does not claim that Carbocol could have done better, but rather notes the highly political atmosphere in which decisions were made in Colombia and the lack of publicly available economic and financial analysis—conditions which favor the MNC.

D. Structure of Demand

In this section we discuss considerations in the consumer choice of coal as a feedstock and the selection of sources of coal supply. The principal substitutes for steam coal are oil, gas, and nuclear power. The interplay between the price of oil and coal can be appreciated from Figure 2, where the cost of generated electricity is given as a function of the price of fuel. Three curves are shown. Curve A *roughly* corresponds to a new baseload coal-fired power station. Curve B *roughly* corresponds to a new baseload oil (or natural gas) generating station, and Curve C to an existing oil-fired station. As can be seen from Table IV, delivered coal prices in Europe and Japan are about $\$2.70/10^6$ Btu. Thus, coal provides cheaper electric power than a new oil plant that burns fuel at $\$4.25/10^6$ Btu or an existing oil plant that burns fuel at $\$4.70/10^6$ Btu. Residual fuel oil prices (to U.S. electric utilities) have been about $\$5.00/10^6$ Btu during the year ending in mid-1982.[30] Coal is therefore a lower cost

28. *See generally:* Kline, *The Coal of "El Cerrejon:" An Historical Analysis of Major Colombian Policy Decisions and MNC Activities*, 35 INTER-AMERICAN ECON. AFFAIRS 69 (1981).

29. *Id.* at 85–89.

30. U.S. DEP'T. OF ENERGY, MONTHLY ENERGY REVIEW 90 (Jan. 1983).

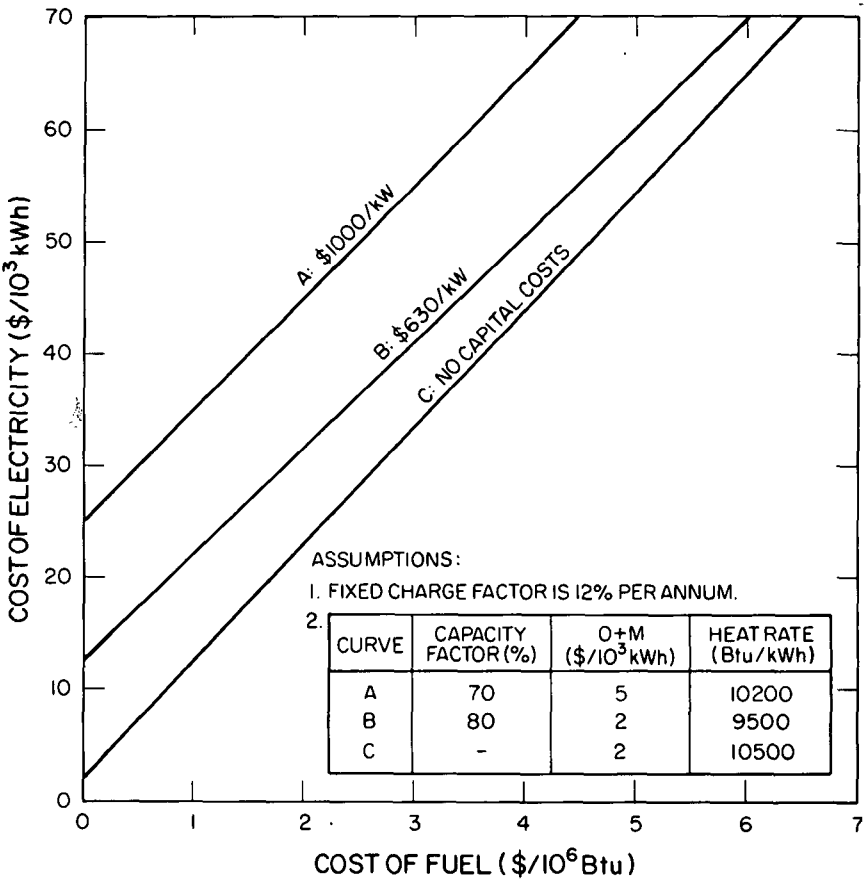


FIGURE 2. The cost of generating electricity from oil and coal.

choice for Europe and Japan unless oil prices soften further. However, the relative youth of oil and gas boilers, high interest rates, and tight capital markets retard the substitution of coal for oil and gas.

The economics of coal versus nuclear power are very close, depending on expectations regarding construction schedules, fuel and capital costs, and interest rates. Thus political as much as economic factors explain the contribution of nuclear power in different countries.

Considering the relatively high ratio of fuel input to energy product costs in the electricity sector[31]—the predominant user of steam coal—

31. An estimate of delivered coal prices (imported or subsidized domestic) in Europe is 15–25 mills/kWh (1977$). Capital and operating costs of electricity generation are in the range 20–25 mills/kWh. *See* A. BAKER & M. PRIOR, THE ECONOMICS OF ELECTRICITY FROM COAL NUCLEAR AND WIND ENERGY 21,31 (IEA Coal Research, 1980).

one might expect coal buyers to select supplies exclusively on the basis of price. But, reliability of supply may also influence utility purchasing practices. This is due to the volatility of coal markets[32] and the charter of regulated or national utilities to supply *reliable* power. The extent to which consumers address these concerns through the diversification of sources of supply is unclear.

E. Government Policy

At least four kinds of government policies affect trade patterns: the formation of economic blocs, preferential trading patterns or embargoes between countries, export and import quotas and tariffs, and subsidies to domestic production.

Blocs or common markets are relevant to Europe with the European Economic Community (EEC) and the eastern European Council of Mutual Economic Assistance (CMEA). The CMEA does not appear to have a formal energy trade policy. Maddock, however, describes the increased energy dependence of eastern European nations on the Soviet Union.[33] The Soviet Union faces a difficult choice between hard currency earnings from oil and gas exports to the West and trade with CMEA partners. Maddock believes the Soviets will choose the latter course in return for increased economic integration within CMEA. If this view prevails, one sees Polish and Soviet coal export potential as an erratic residual of CMEA supply and demand.

The coal-related policies of the EEC are advisory. Nonetheless, aggregate steam coal import demand of EEC nations is significant in total world import demand. The EEC nations enjoy similar importance in wheat trade and have established a variable import levy on wheat imports. Carter and Schmitz argue that this tariff generates monopsony power and plays a critical role in wheat price formation for the EEC—an example that could be applied to steam coal imports.[34]

Politically motivated embargoes have had little effect on coal trade. A few relatively small importers, including Ireland, Sweden, and Finland, prohibit imports of South African coal.[35] Preferential trade patterns may

32. Witness the virtual cessation of Polish exports in 1981, the recurrent labor strife in Australia, the port backlog and demurrage costs in U.S. ports in 1981, and the potentially explosive racial relations of the Republic of South Africa.

33. Maddock, *Energy and Integration: The Logic of Interdependence in the Soviet Union and Eastern Europe*, 12 J. COMMON MKT. STUDIES 21 (1980).

34. Carter & Schmitz, *Import Tariffs and Price Formation in the World Wheat Market*, 61 AM. J. AG. ECON 517 (1979).

35. AUSTRALIA DEP'T OF TRADE AND RESOURCES, COAL DEMAND STUDY, DRAFT: AN ANALYSIS OF CURRENT AND PROJECTED COAL IMPORT REQUIREMENTS OF MAJOR PROSPECTIVE CONSUMING COUNTRIES FOR AUSTRALIAN COALS 3.6.2, 4.2.3, 4.5.3 (1981).

have a modest effect on coal markets. The Japanese might, for example, favor U.S. coal to counter their massive trade surplus with the United States. However, it is unclear how such a national preference would be transferred to coal buyers.

Tariffs on coal trade are rare or nonexistent, but quotas are found among exporters and importers. South Africa's export quota merits special attention.[36] South Africa has virtually no indigenous resources of petroleum and natural gas and depends on coal for about 80 percent of primary energy consumption. The South African Department of Mineral and Energy Affairs recently projected an increase in domestic coal consumption from about 90 Mt/yr in 1980 to 740Mt/yr in 2020. In 1974, the government instituted an export quota allocated to individual companies, ostensibly to preserve resources for long-term domestic use. In July 1981, the government again increased the quota from 44 Mt/yr under phase III of the export program to 80 Mt/yr.[37] The phase IV export levels are likely to be reached by the early 1990s.

A variety of issues bear on the setting and distribution of the South African quota. First, quota levels are justified by reference to coal reserve levels. The official reserve estimate doubled from 1976 to 1981.[38] Thus, the 80 million tons per year export level over 30 years represents less than five percent of official reserves. Second, criticism of the inefficiency of domestic price controls may increase, though higher electricity prices would have an adverse effect on the economics of extraction and processing of other traded commodities, notably gold and diamonds. Third, squabbling persists over the allocation of export licenses. A portion of quotas has been awarded to MNCs to encourage the flow of oil to South Africa. In addition, independent coal companies seek to enter the lucrative export market at the expense of the major mining houses. In any case, it seems reasonable to assume that the South African export quota is a potential vehicle to increase market power, rather than a mere constraint on industry.[39]

Many of the principal coal importing nations have protected domestic industries in the past. Germany has a quota system that links imports of coal to consumption of domestic coal. France, West Germany, Belgium, Japan, and the United Kingdom subsidize domestic coal production by

36. *See generally:* South Africa's Coal Sector, Memo from American Consulate General, Johannesburg, Republic of South Africa to U.S. Department of State, (Feb. 5, 1982).

37. *South Africa Export Quota Lifted,* 297 MINING J. 185 (1981).

38. *Recoverable Coal Reserves Increased,* 297 MINING J. 42 (1981).

39. In July 1982, the Republic of South Africa allocated the phase IV quotas. Over half the tonnage went to the TCOA or its major conglomerate members. A number of additional allocations went to small producers, but reportedly with instructions to market cooperatively. *See New South African Export Quotas Bring in Wide Industry Participation,* INT'L. COAL REPORT 2,3 (July 16, 1982).

such practices as a state production monopoly, preferential purchasing by state utilities, or direct subsidies.[40] Generally, domestic production levels are likely to remain flat due to limited opportunities for new mine openings and political pressures against closing inefficient mines.

Aside from the four classes of government policy discussed above, there are a variety of other influences governments or nations may have on trade. In Australia, the federal government must approve export contracts (prices and quantities), and the state coal boards must approve new mine openings. Federal government power has been used in slack markets to compel producers to bargain jointly, and to counteract the market power of buyers.[41]

In Japan, private industry and government often act in concert. Ozawa, for example, describes the Japanese system of "resource diplomacy" involving foreign aid grants and low interest loans from the Export-Import Bank of Japan to support resource development ventures initiated by the private sector.[42]

In summary, the effect of government policy, in some cases, is to further diminish the competitive appearance of numbers of buyers (notably in Japan and potentially in the EEC) and sellers (Australia and, especially, South Africa).

F. Summary of Market Structure

In the wide-ranging discussion above, we reviewed basic conditions of the market and conventional elements of market structure as a means to identify participants with potential to exercise market power. Table IX provides a summary of this analysis. The upper part of the table is a laundry list of types of coal producers and consumers by country. Some of the elements of the market structure analysis—spatial distribution of resources, barriers to entry, market shares, and government policy—provide a filter to identify the key actors in the market.

On the demand side, we reported a trend toward national coal buying. Yet, with the exception of Japan, most nations have a relatively small share of even regional markets. The nations of the EEC might, however, adopt a unified policy or strategy for coal development and purchasing. On the supply side, South Africa clearly has the appearance of an oligopolist enjoying very low production costs, a tight domestic producer cartel, and government export licenses and quotas. Poland, with low transport costs to western Europe and a state trading monopoly, also

40. *See generally* GASKIN, *supra* note 4.

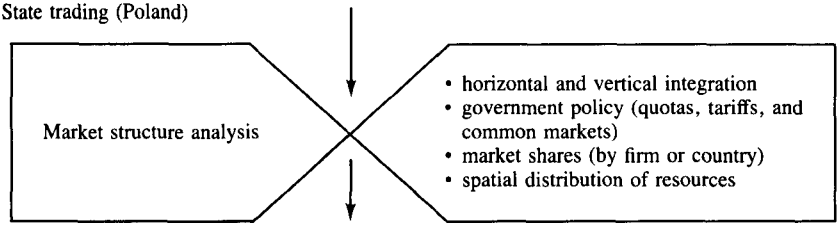
41. Bambrick, *Australian Mineral Commodity Marketing*, 6 RESOURCES POLICY 166 (1980).

42. Ozawa, *Japan's New Resource Diplomacy: Government Backed Group Investment*, 14 J. WLD. TRADE LAW 3 (1980).

TABLE IX.

Structure of International Steam Coal Market

Types of Participants	
Producers	*Consumers*
Producer cartel (South Africa)	Regional utilities (Germany, Japan, U.S.)
Private firms (Canada, Australia, U.S.)	Utility coal-buying co-ops (Holland, Belgium and others)
MNCs (throughout the world)	State importing or development companies (Japan, Spain, France and others)
State monopolies (developing countries)	National utilities (France, Korea, Taiwan, Japan and others)
State monopolies (France and other importing nations)	General trading companies (Japan)
State trading (Poland)	



Key Actors

Producers	*Consumers*
South Africa	Japan
Poland	EEC (potential)
Australia	
MNC	

represents a supplier with potential market power. Even with the possibility of foreign investment, the Australian steam coal export industry is relatively concentrated. Mechanisms such as the federal export permit system, state ownership of railroads, and labor union power bolster the opportunities for Australia to exercise market power.

We have found no data to indicate the market share of individual MNCs. It is conceivable, however, that combined production of a MNC and its subsidiaries in the United States, Canada, Australia, South Africa, and developing countries, could represent a significant share of total trade. Finally, there is a remote possibility of a formal producer cartel.

Given the diverse elements of market structure, it is not surprising that this analysis reveals no neat, simple market structure such as a producer or consumer cartel. We are also far from ideal market conditions such as easy entry and exit, factor mobility, many small buyers and sellers, and no institutional distortions. Caves calls the "essence of oligopoly ... the

recognition of market interdependence."[43] In other words, the market strategies (in terms of prices and quantities) of buyers and sellers are interdependent. This seems to be a general, but accurate, characterization of the international steam coal market. How strategies are formulated is the subject of the next section.

III. MARKET CONDUCT

In the last section we were concerned with organizational characteristics of the international steam coal market—that is, market structure. In this section, we explore the pricing and production strategies of agents involved in the market—that is, market conduct. Following McCalla,[44] we consider the objectives and strategies of the most important participants in coal trade (as defined in Table IX).

A. Objectives

The objective of the TCOA (the producer cartel in South Africa) is to maximize long-run cartel profits. In tandem, the South African government wants to maximize long-run producer earnings, but is also concerned with the conservation of coal for domestic consumption for the very long run.

Left to its own, Poland's state coal trading company would also attempt to maximize long-run profits or hard currency export earnings. But the direction of the Polish economy seems closely bound to CMEA (the Council of Mutual Economic Assistance) and the Soviet Union, obscuring the statement of Polish objectives.

The developing country monopolies presumably have multiple objectives: maximization of long-run rents from coal, information transfer and regional economic development, and substitution of coal for petroleum in domestic consumption to reduce oil imports or free oil for export. Domestic politics may also affect the operation of the state monopolies.

The MNCs are not only horizontally integrated in coal production, but typically produce substitute energy commodities or other minerals. Energy producing companies may also be vertically integrated with oil refineries, coal conversion complexes, and marketing and distribution networks. Thus, while MNCs attempt to maximize long-run profits, conflicting

43. Caves, *supra* note 23, at 1.

44. McCalla, *Strategies in International Agricultural Marketing: Public vs. Private Sector*, in INTERNATIONAL TRADE AND AGRICULTURE: THEORY AND POLICY 209 (1979). McCalla conducts a modified analysis of market structure, conduct, and performance in wheat and coarse grain trade. After identifying the key actors in the market, McCalla characterizes their objectives and discusses their potential strategies in a multi-lateral framework. His intent is to identify the dominant forces in market operation, especially price formation, and to develop hypotheses for empirical or theoretical testing.

objectives may exist among subsidiaries producing different products in different nations.

The Japanese, typical of some other consuming nations, face the conflicting objectives of promoting coal substitution to reduce oil imports, minimizing fuel (and capital) costs, and ensuring reliability of supply. It is worth noting that the Japanese strategy for economic development involves a shift from resource intensive basic industries, with heavy dependence on imports of primary commodities, to high value-added manufacturing (knowledge-intensive) sectors. In that regard, Ozawa suggests that

> Japan's primary goal in making overseas extractive investments is to stabilize its sources of supply. Profitability of a specific extractive investment is rather a secondary consideration.[45]

However, whenever a national goal appears to conflict with private, profit maximizing goals, it is important to ask how the national goal is conveyed to the private sector. Without such a mechanism, buyers may continue to act on the basis of private economic criteria.

B. Strategies

At present, the strategies of the Republic of South Africa and Poland seem most important to development of the steam coal market. An industry analyst has suggested that the primary South African strategy is to set FOB port prices that will undersell the U.S. delivered price to Europe by a "few" dollars.[46] The analyst reported that until mid-1981, the Poles did the same. (This strategy is consistent with the prices reported in Table III). Thus, South African and Polish output is determined by U.S. supply costs.

It is conceivable that the South Africans in particular could assume a more active price leadership role, affording greater discretion about output levels and, more importantly, deterring entry into the market of developing countries and new producers in Australia, Canada, and the United States. Some evidence of such a role can be found in the 1982 agreement between the TCOA and Japanese steelmakers that escalated soft coking coal prices only $2/t (3.6%) above the 1981 level.[47] Coal Outlook reports that western U.S. suppliers to Japan cannot compete with that price.[48]

45. Ozawa, *Japan's Resource Dependency and Overseas Investment*, 11 J. WLD. TRADE LAW 52 (1977).

46. Telephone conversation between David Abbey and Shirley Strzelecki, Editor, Coal Week Int'l, February 17, 1982.

47. Of course the weakened position of the Sourth African currency (rand) is one explanation for this modest price rise.

48. *South African Price Affects West*, 6 COAL OUTLOOK 12 (1982).

The pricing strategies of Australian producers may hinge on the opportunities for informal cooperation among firms and the exercise of export controls by the federal government, as well as the escalation of rail tariffs and the wage gains of labor unions. At present, Australian steam coal exporters are seeking shares of the European market—for example, by investing in ports and coal-fired ships to reduce transportation costs. Competition in Europe may require lower FOB port prices than necessary to compete in Japan (assuming price discrimination is not possible). Some producers advocate abandonment of the European market and concentration on the east Asia market with potentially higher profit margins. Pursuit of such a strategy depends on the possibility of limiting competition and total exports.

For the developing countries, pursuit of joint venture agreements with MNCs or consumers seems necessary. Such agreements may require initially favorable terms for foreign investment, because there is certainly no scarcity of investment opportunities. Nevertheless, foreign investment provides the host country with more thorough exploration of resources, the transportation infrastructure necessary for futher development (deep-draft ports and rail lines), and greater familiarity with international market opportunities. Because Colombia's joint venture with Intercor commits only 15 Mt/yr, Colombia may pursue subsequent development independently. Developing countries such as China and Indonesia also may grant attractive terms for export projects but require fractions of mine output to supply the domestic market.

The heterogeneity of activities and interests of vertically or horizontally integrated MNCs makes any discussion of strategy difficult. Nonetheless, we offer several important observations. First, corporate risks are minimized by investing in production capabilities in the world's most stable economies and by having spatially diverse production capability. Thus, Helleiner cites a United Nations' study that indicates that between 1970 and 1973 over 80 percent of market-economy investment in minerals exploration occurred in Australia, Canada, the Republic of South Africa, and the United States.[49] Perhaps not surprisingly these are the dominant exporting countries in the international coal market. More recently, coal exploration and development activities of the MNCs have expanded to developing countries.

Second, and somewhat contradictory to the first point, is the fact that MNCs with spatially diverse and multiproduct production capacity benefit most from market instability.[50] Such organizations can react quickly to

49. Helleiner, *Structural Aspects of Third World Trade: Some Trends and Prospects*, 15 J. DEVEL. STUDIES 70 (1979).

50. McCalla, *supra* note 44, at 227.

changes in market conditions, to price changes, and technological developments. Third, a proliferation of joint ventures amont MNCs increases market power and opportunities for collusion.

The strategies pursued by the Japanese government and trading companies may be representative of consumers in general. Most important, keen competition among suppliers is desirable. The Japanese do this in part by advertising an intent to diversify supplies. Their actions in 1980 and 1981 seem to have provoked a near frenzy among producers and reserve holders in the western United States that diminished within a year. The more effective strategy to promote competition of course is to reach joint venture agreements with developing countries or potential producers in the United States, Canada, and Australia.

A subtle aspect of Japanese resource acquisition is what Ozawa calls the system-focused strategy,[51] which relates to the role of general trading companies discussed earlier in the paper. In joint venture agreements, a Japanese subsidiary may be relatively generous in granting concessions. Yet the industrial group benefits in other ways, such as supply contracts for capital goods. In addition, the Japanese retain control of the flow of resources. With automated loading facilities, deep-water ports, and computer control of shipment rates and stockpiles, the Japanese achieve economies in logistics that preserve the competitiveness of industry.

IV. MODELS OF IMPERFECT COMPETITION

The purpose of this section is to connect the highly institutional analysis of the previous sections with economic theories of imperfect competition. Our goal is to identify plausible behavioral theories for coal trade. As indicated previously, it is probable that the United States in particular will remain as a competitive fringe, no matter what structures and conduct evolve in the remainder of the world. Australia, Poland and the Republic of South Africa have the *potential* to act non-cooperatively as oligopolists or jointly as a cartel. Japan can act as a regional monopsonist in the Pacific basin, because it is the dominant coal consumer in that region. Finally, European countries can form a buyer cartel, setting tariffs or quotas for the EEC as a whole. The potential for MNC market manipulation exists but is difficult to quantify, given our current state of information.

Thus, a host of potential market structures exist with an even larger array of potential strategies for pricing and output decisions. We are not suggesting that any of these structures actually characterize the market; we only wish to explore *potential* structures. (The logical next step is to

51. Ozawa, *supra* note 45, at 68.

econometrically test hypotheses about market conduct.) We now turn to a brief review of theories of cartel and oligopoly/oligopsony operation.

A. Cartels

Conceptually, the most simple form of market manipulation involves collusion or cooperation on the part of several market participants. A cartel can form on either the producer or consumer side, although we are most accustomed to producer cartels. The behavior of natural resources cartels has received renewed attention over the past decade, due principally to the rise of OPEC.[52]

As stated by Osborne,[53] there are four internal decisions for cartel operation: location of the frontier of possible price and output levels for cartel participants (the contract surface); choice of price and output levels for cartel members (the sharing problem); and detection and deterrence of cheating by cartel members. Osborne suggests that locating the contract curve and detecting cheating are the principal problems facing a perfect cartel (i.e. where payments from one cartel member to another—side-payments—are possible). For a perfect cartel, joint revenue maximization is the cartel objective. However, if side-payments are excluded (as would likely be the case with an international coal cartel), the problem of determining the appropriate share of profits for each cartel member becomes more significant.

If side payments are excluded and the product of the gains to each member from forming a cartel is maximized, one arrives at Nash's well known solution to the bargaining problem. But the Nash equilibrium is not the sole solution to the bargaining problem. For instance, a simple (and thus enforceable) pricing rule (such as uniform price for all members) could result in another solution.

In summary, while there is no single solution to the cartel pricing problem, the set of possible outcomes (that is, the bargaining set) can be restricted. If there are not large gains from cartel formation, then the bargaining set may be quite small. We have also suggested two possible strategies for operating a cartel: joint profit maximization and maximization of gains from cartel formation.

In any case, a cartel is an unlikely model for the steam coal market. We mentioned previously the difficulty of side-payments in international markets involving nations as key actors. Scherer[54] suggests some other practical problems. First, with non-homogeneity and spatial differentia-

52. Most recent work has involved case studies of cartels for oil or non-energy commodities. for a review, *see* C. KOLSTAD, D. ABBEY & R. BIVINS, MODELING INTERNATIONAL COAL TRADE 34 (Los Alamos National Laboratory, 1983).

53. Osborne, *Cartel Problems*, 66 AM. ECON. REV. 835 (1976).

54. F. SCHERER, *supra* note 21, at 199.

tion of products, coordination of policy is difficult, because it must address not only price but product specifications (for example, coal ash and sulfur content) and transportation costs. Second, secrecy and retaliation lags, as occur under long-term contracting, deter coordination among cartel members. Third, the lumpiness or infrequency of orders encourages members to undercut prices. Finally, industries characterized by high fixed costs such as coal mining are susceptible to breakdowns of price discipline in periods of slack demand.

B. Non-Cooperative Equilibria

We now turn to the case where there is no collusion among the participants in the coal market. In this category fall the extremes of perfect competition and monopoly or monopsony. In between lie oligopoly, oligopsony and bilateral oligopoly.

Since monopoly or monopsony are special cases of oligopoly and oligopsony, we consider oligopoly, oligopsony and bilateral oligopoly. Each of these cases involves a set of participants with the potential to exercise market power. Our analysis of how these participants interact is largely independent of whether they are consumers or producers, and thus for convenience, we concentrate on oligopoly models.

The oldest and best known model of oligopoly behavior derives from Cournot, who hypothesized that oligopolists determine output based on the output levels of their opponents.[55] The Nash equilibrium which results is often called a Cournot-Nash equilibrium.[56] Betrand hypothesized a similar model with prices as the observed variable instead of quantities. In the 1930s von Stackelberg took a step forward suggesting that some oligopolists ("leaders") might react not only to their opponents' output levels but to how these output levels are affected by the leaders' actions. Bresnahan has recently synthesized these approaches into the concept of a full information of "consistent conjectures" equilibrium where each oligopolist reacts to his opponents' reaction *functions*.[57]

This variety of behavioral models is the principal obstacle to determinant analysis of oligopoly behavior. McCalla's classic model of duopoly in world wheat markets makes a variety of assumptions about duopoly operations which yield a unique set of prices and production levels.[58]

55. For a review of models of oligopoly equilibria, *see* J. FRIEDMAN, OLIGOPOLY AND THE THEORY OF GAMES (1977).

56. The Nash equilibrium referred to here should not be confused with Nash's solution to the cartel bargaining problem.

57. Bresnahan, *Duopoly Models with Consistent Conjectures*, 71 AM. ECON. REV. 934 (1981).

58. McCalla, *A Duopoly Model of World Wheat Pricing*, 48 J. FARM ECON. 711 (1966). *See also*, Alaouze, Sturgess & Watson *Oligopoly Pricing in the World Wheat Market*, 60 AM. J. AG. ECON. 173 (1978).

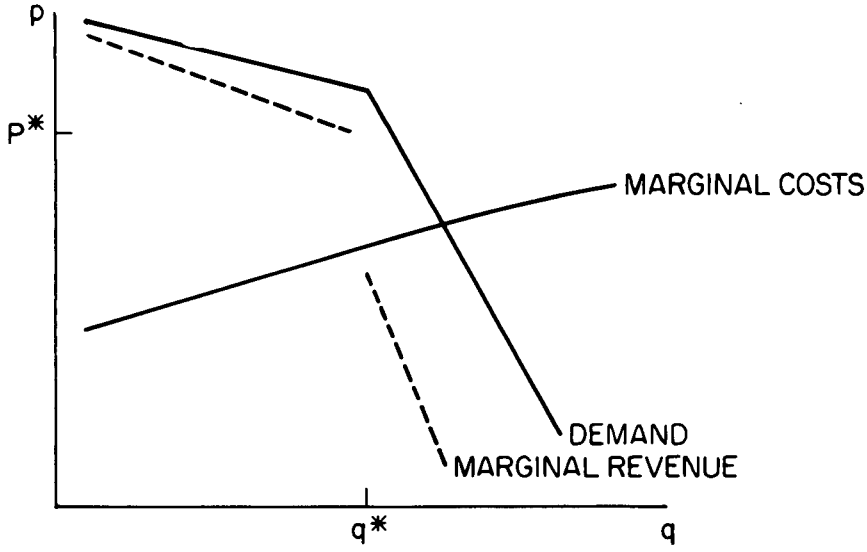


FIGURE 3. Hypothetical demand and marginal revenue curves faced by regional monopolists.

Most of the handful of other applied analyses assume only a Cournot type model.[59]

C. Policies to Deter Entry

A final issue requiring treatment is how oligopolists (if they exist) may deter entry of competitors. We suggested previously that oligopolists will likely be countries, or in the case of the EEC, a group of countries. Much of the potential producer market power derives from a fortunate initial endowment of resources. Nevertheless, producing countries in particular face potential new competitors from developing countries.

One of the simplest ways to explain producer market manipulation is to view each regional monopolist as facing a kinked demand curve (Figure 3). If production costs are in the vicinity of the kink, optimal (limit) pricing will be at or just below that of the competitive fringe (as indicated in Figure 3). This result is consistent with the discussion in prior sections which suggested that the Republic of South Africa prices a "few" dollars below the United States (in delivered price terms). But limit pricing may not be consistent with classic oligopoly models such as Cournot's. Implicit

59. *See, e.g.*, Levhari & Mirman, *The Great Fish War: An Example Using a Dynamic Cournot-Nash Solution*, 11 BELL J. ECON. 322 (1980); and Salant, *Imperfect Competition in the International Energy Market*, 30 OPERATIONS RESEARCH 252 (1982).

in limit pricing is consideration of how one's opponents react to pricing actions in the vicinity of the kink.

Gaskins provides the first fully dynamic analysis of limit pricing strategies.[60] Gilbert and Goldman treat the case of dynamic limit pricing for an exhaustible resource cartel.[61] Salant explores in detail limit pricing strategies for the OPEC cartel, which faces a "backstop" alternative to oil.[62] Spence proposes an alternate theory to explain deterrence to entry of competitors.[63] He suggests that excess capacity on the part of oligopolistic firms can be an effective deterrent because the potential entrant faces competition which has the capacity to reduce potential profits to zero. On the other hand, Scherer observes the common occurrence of new entry and capacity expansion leading to the breakdown of oligopolist's market shares.[64]

V. CONCLUSIONS

In Parts II and III we identified those actors in the international steam coal market with the potential to exercise market power—at a minimum, the Republic of South Africa, Poland, Japan, Australia, and the European Economic Community. Unfortunately, the discussion of strategies and market conduct in general was speculative or inconclusive.

The review of theories of imperfect competition in the last section suggested the applicability of non-cooperative models of oligopoly and oligopsony to the steam coal market. However, that review was likewise inconclusive, because of the variety of imperfect market models and the difficulty in reducing this variety based on specific characteristics of the steam coal market.

The challenge for the future is to compare implications of behavioral models for pricing and production decisions with data on market prices and trade flows: in other words, to test hypotheses about market conduct.[65] Such research is complicated by a dearth of data due to the youth of the steam coal market. However, data are slowly becoming available on historic prices and flows for steam coal, and some engineering estimates have been made of production relations for steam coal. Although testing

60. Gaskins, *Dynamic Limit Pricing: Optimal Pricing Under Threat of Entry*, 3 J. ECON. THEORY 306 (1971).

61. Gilbert & Goldman, *Potential Competition and the Monopoly Price of an Exhaustible Resource*, 17 J. ECON. THEORY 319 (1978).

62. Salant, *Staving off the Backstop: Dynamic Limit-Pricing with a Kinked Demand Curve*, in II ADVANCES IN THE ECONOMICS OF ENERGY AND RESOURCES 187 (1979).

63. Spence, *Entry, Capacity, Investment and Oligopolistic Pricing*, 8 BELL J. ECON. 534 (1977).

64. F. SCHERER, *supra* note 21, at 252.

65. For some exploratory work on this line *see* C. KOLSTAD, D. ABBEY & R. BIVINS, *supra* note 52, and C. KOLSTAD and D. ABBEY, THE EFFECT OF MARKET CONDUCT ON INTERNATIONAL COAL TRADE (Los Alamos National Laboratory, 1983).

hypotheses about market conduct taxes current econometric capabilities, methods are becoming available.[66]

Our basic conclusion, derived from structural analysis, is that the international steam coal market does not appear to be perfectly competitive. This finding has wide-ranging policy implications, from the U.S. Government's interest in increasing coal exports to the western European and Japanese efforts to reduce dependence on imported oil and gas. We hope that further research can define a specific model of market operation to be used for quantitative policy analysis.

66. For a brief review *see* Bresnahan, Identificaton of Market Power (1981) (unpublished paper, Econ. Dept., Stanford Univ.).