"Transportation and Market Shares in the World Coal Trade"

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Coal has long been an important ingredient for industrial growth. However it is well known that since World War II the majority of the world's increased energy consumption (about 80 per cent) has been supplied by the more convenient and, until recently, cheaper oil. But all this has changed.

Oil supplies are being depleted rapidly and the OPEC cartel has been successful at imposing dramatic price increases and restricting production. It also seems increasingly likely that oil supplies may be used as an international political weapon. Coal is seen as the major alternative source of energy in the near future. Nuclear power development is not expanding as rapidly as was expected due to environmental and safety concerns. There are a variety of other potential energy sources (solar, nuclear fusion, geothermal, tidal, etc.) but these require substantial R&D before they become a practical source of energy. They are the next generation's fuel.

Coal is seen as the "bridge to the future",[1] an energy source which is available at moderate costs with known technology for the next couple of decades at least. This has been well publicised, most notably by the MIT World Coal Study (WOCOL) which has reviewed and projected world reserves, production, consumption, and trade. Numerous other forecasts exist; all predict increased reliance on coal and major expansion in the world coal trade.

This paper focuses on the importance of transportation components in enabling this expansion of trade to take place, and how transportation factors will affect Canada's and other countries' prospects in this trade. The paper begins with a brief review of the current situation in the world coal trade: production, consumption, and trading patterns. Next, the paper summarises the relative size and significance of various transportation components from mine to overseas port. The paper contrasts the costs and important operating characteristics of the coal logistics systems for the four major long distance coal suppliers: Australia, Canada, the United States and Republic of South Africa. Finally, the paper reviews some trends and developments in transportation and speculates on the implications of these trends for the various countries' prospects in the world coal trade.

A. The World Coal Trade

Coal resources are scattered widely about the world - much more so than oil for example - so practically all industrialised countries are able to supply at least part of their needs by domestic production. Only a fraction of world coal production is traded internationally. A significant portion of the world coal trade is fairly localised, e.g., from the U.S. to Canada and from Poland to other European nations. Nonetheless, coal is of increasing importance in world trade and there is every prospect of dramatic increases in this trade.

Current world coal trade is dominated by the movements of metallurgical or coking coal. As some nations exhaust their own sources of low cost high quality coking coals, they will increasingly turn to coal exporters for supplies of high quality metallurgical coal. Such trade can be expected to increase roughly in proportion to the growth of GNP in coal importing nations (although technical progress has been gradually reducing the amounts of coal required per tonne of pig iron or finished steel production).[2] However, it is expected that the future coal trade will increasingly consist of steaming or thermal coal used for thermal generation of electricity. World power demands are growing and the finite limits of resources - especially oil - are increasingly apparent.

Exhibits 1 and 2 show the major movements of international seaborne coal. The five largest suppliers - Australia, Canada, Poland, South Africa and the United States - account for 92 per cent of 1979 coal exports.[3] Japan and the nine EEC countries imported about the same amounts in 1979, accounting for over 77 per cent of world coal trade. The influence of distance is evident in the pattern of world trade. Europe is supplied primarily from Poland, South Africa and the United States. The largest supplier to Japan is Australia (45 per cent in 1979) with Canada and the U.S.A. combined supplying a similar amount.

The volume and pattern of future coal trades will be influenced by many factors: the availability and quality of coal resources, the costs of mining and transport, government policies in both importing and exporting nations, and, possibly, geo-political and diplomatic considerations.

Exhibit 3 contrasts the estimates of total coal resources, recoverable reserves, 1977 production and export levels and WOCOL estimates of export levels by the year 2000. It should be recognised that estimates of resources and recoverable reserves must be treated with caution. The salient points to draw from Exhibit 3 are two. First, the vastness of resources and recoverable reserves relative to current production levels suggest that coal can serve as the world's main energy source for decades to come. This is subject to environmental acceptability, adequate prices, incentives to develop mines and provision of the necessary infrastructure to enable these developments to take place. A second point is that there is only a loose correlation between the size of national resources, recoverable reserves, and the importance of the country as an exporter.

In recent years the United States, Poland and Australia have been the three largest exporters. Poland's resources are estimated at far less than most other major producers but a relatively high percentage is thought to be recoverable economically. WOCOL projections are for Poland to continue to be an important coal exporter but not much larger than at present. In fact coal exports from Poland have fallen in recent years. South Africa also is thought to be able to economically exploit a relatively high percentage of her total geological resources of coal and a significant amount can be exported. Canada, on the other hand, appears able to exploit only a small fraction of total resources but that fraction is important for prospective world trade. Canada exports the highest percentage of domestic production of any country (although this is misleading in that Canada is also an importer of U.S. coal in the east; it is western Canadian coal which is exported). The estimates of United States' geologic resources are second only to the Soviet Union. WOCOL projects the U.S. to continue to be the largest exporter of coal. Australia is projected to rival the U.S. as a coal exporter. Australia's total resources are not large relative to world supplies but they are especially important for future trade. Australian coal is relatively close to tidewater and relatively modest amounts of coal are needed for domestic consumption.

The U.S.S.R. and China are enigmas to future world coal trade. Both possess vast reserves and are major producers and consumers of coal. Depending on their government priorities (e.g., the importance attached to foreign exchange earnings) either or both could emerge as major export coal suppliers.

Setting aside the Soviet Union and China, four countries emerge as especially important for prospective long distance coal trades: Australia, Canada, the Republic of South Africa, and the United States. The market shares of these countries are influenced by a number of factors including: mining costs; royalties and other tax considerations; various quality attributes of the coal; dependability of supply; and transportation.

It is well known that transport costs can comprise more than one half of the delivered price of coal overseas. Different countries face different transportation challenges in supplying export coal. These different challenges - and the various countries' success in overcoming them - are important factors in explaining current and prospective market shares.

Various organisations have examined and reported on the importance of transport costs for coal exports, including WOCOL. This paper provides a bit more detail about the operating conditions and impacts on transport costs for the various countries. Rail, port and ocean shipping costs are reviewed along with trends and developments in these cost components. These trends may have implications for prospective market shares of Canada and the other coal-supplying countries. But before I review the rail transportation component, it is worth mentioning that a considerable part of mining costs actually are transportation and logistics expenditures: there is overburden to be moved; coal is handled and moved for crushing, washing, stockpiling and loading on to rail cars; there are inventory costs associated with the storage of coal. But, as is customary, I start the discussion of transportation with the rail to port movement rather than discuss the transportation component of mining costs.

B. Rail Transportation

Although other modes of transport are involved in coal exports (notably inland barges in the U.S. and trucks in New South Wales, Australia), the majority of hauls are by rail. This section contrasts the rail freight rates and operating conditions facing coal exports in the four long distance coal supplying countries. Figures presented are in 1980 U.S. dollars.

Exhibit 4 summarises a number of features of rail transportation and rates in the four countries. The "bottom line" appears at the top. The size of rail charges varies notably across the four countries. The substantial range for Australia reflects the varying distances from mines to ports. In some cases the distances may be only a few miles.[4]

Canadian rail rates are high on a per ton basis but are low on a ton-mile basis. Canadian coal exports must traverse long distances, face challenging terrain and weather, and travel over congested single track lines. It is generally conceded that Canadian railway performance is unmatched by our export competitors; the railways' performance is a major factor in Canada's competitiveness in the world coal trade.

I should emphasise that these are rail rates rather than costs. The basis for rate making is noted in the second row of Exhibit 4. The classifications are somewhat subjective but they should serve as a guide. It is well known that Canadian railways practice value of service pricing. Queensland Railways, a department of the state government, also practices value of service pricing although the freight rates are set/negotiated by the Queensland treasury department rather than by railway management. The rates are complicated by rebates to shippers who have helped finance public infrastructure (these rebates are not deducted from the figures in Exhibit 4).

The State Rail Authority of New South Wales, also a department of the state government, practices some value of service pricing but is fairly rigidly tied to a tonne-kilometer formula. For some mines, circuitous rail routes result in rail freight rates which are higher than more direct truck haulage rates. The railway does not make rate concessions from its general formula so much of this traffic is lost to the trucks.

The U.S. railroads have long been constrained in their pricing freedom by the ICC. Hence, until recently I would characterise their rate-making as a ton-mile formula based on a cost of service notion. The Staggers Act will grant increased rate freedom but not to the same extent as that enjoyed by Canadian railways. Protection of coal shippers is recognised by many as one of the major reasons for limiting the railways' rate freedom. Hence, future rail rates can be described as constrained value of service pricing.

I know less about rate making practices in South Africa. The railway is a government department and the development of the Richard's Bay coal terminal, mine development, and rail infrastructure and pricing were all closely coordinated. The unit train rates are special contract rates.

Exhibit 4 also identifies a few salient operating characteristics of the various rail systems. The U.S. east coast ports are extremely limited in stockpile capacity and must load coal directly from the rail cars to the ship. This type of operation also reflects the immense number of coal types handled through U.S. east coast ports (almost 1000 at Hampton Roads). The need to store coal in rail cars for direct loading to ships limits train operations to block movements rather than unit train operations, and requires an immense numer of rail cars on hand and in the system in order to have the necessary inventory of coal on hand to load the ships. It is recognised to be a costly system. Demand has grown far beyond original expectations and the supply system which has evolved is not what would be designed if starting from scratch. Eventual development of new export ports with adequate stockpile capacity will enable utilisation of more efficient unit train operations as are commonly employed in other coal movements in the United States. New facilities are especially necessary for lower-valued thermal coal exports.

It is necessary to separate discussion of Australian operations between two regions. Coal mining and trade has been established much longer in New South Wales than in Queensland. In New South Wales, the volumes of coal move over a rail system not really designed to handle it, much like the U.S. east coast in this regard. Distances from mine to port are relatively short although there are escarpments which force some circuitous routes and many of the lines are congested despite being double tracked and more. Further, limited stockpile capacity in ports combined with a large number of mines prevents operating the unit trains on dedicated runs. Instead, they must be reallocated in a demand-responsive pattern to move the particular types of coal needed for loading in the next few days. Unit train sizes are much shorter than those used elsewhere. This partly reflects the shorter optimal size of train for short distance movements (a train set can make three trips per day on some routes) but also reflects constrains on rail infrastructure, e.g., short passing loops (sidings).

Queensland, Australia, and South Africa have train operations which resemble North American unit train operations although the terrain is not as rugged as that faced in our western mountain ranges. The most notable difference is that both of these systems are narrow guage. But in other respects, they resemble the operations in western Canada, viz, dedicated trains on a regular route with large stockpile capacity in port so train utilisation can be kept at a maximum.

C. Port Facilities and Costs

The next stage in the coal logistics chain is the port. The port provides receival, storage, reclaiming and ship loading functions. All coal-loading ports are highly mechanised although they may differ from one another in other respects. One significant difference among ports is the amount of space available for stockpiles. Ideally, sufficient stockpiles can be carried to serve as a buffer between rail delivery and ship loading. However, stockpiles require extensive land areas and equipment for reclaiming the stored coal. Different coal types must be kept separate or, in some cases, different coal types blended in a careful sequence. The multiplicity of coal types can reduce effective stockpile capacity to about 60 per cent of its nominal capacity. The three "superports" of Roberts Bank, Hay Point and Richards Bay are so-named because they are modern special purpose ports with large land areas, rapid receival, reclaiming and loading rates, and capable of handling the largest colliers.

In contrast, some major coal exporting ports face constraints on stockpile size and port draft. The immense volume of coal exported through U.S. east coast ports is handled with virtually no stockpile capacity. This is partly because of the scarcity of available land but also reflects the enormous number of separate coal types which are handled. Coal is stored in rail cars and loaded directly to the ship. This requires major investment in rail cars (figuring $65 per ton for coal and $20,000 for an 80 ton car, this is storing $5,200 worth of coal in a $20,000 box). The U.S. east coast specialises in coking coals for which quality control and precise blending are very important. The number of stockpiles which would be necessary to handle this variety of coals, and the size and extent of the reclaiming system, would be costly as well. That is, there is no inexpensive way of handling the immense number of coal types. Increased steam coal trade will consist of larger shipments of fewer types of coal. New ports and/or stockpile areas will be an economic necessity for this trade.

Most Australian ports have limited stockpile areas and several coal types (Hay Point is the exception). In New South Wales, the ports do not accept coal more than 10 days in advance of when a ship is due to load. By skillful juggling of rail scheduling the system runs remarkably well but, as indicated in the previous section, this imposes constraints on the rail system. It must be demand-responsive and thus be able to absorb flucuations in shipments from different origins at different times. New port facilities are being built in Australia but they have not kept pace with the growth of demand. The inevitable result is frequent delays for coal ships. At Port Kembla the existing berth utilisation exceeds 90 per cent. Such high utilisation rates imply that ships normally are queued for several days. Similar problems exist at Newcastle where demand has grown faster than new facilities can be provided. Delays per ship calling at New South Wales' ports amounted to 16 to 21 days on average during 1980-81.[5] The problem of ship delays is less severe in Queensland ports although I have no figures.

The U.S. east coast ports are also notorious for delays to coal-loading vessels. Delays of 30 days per ship are common. With ownership costs running between, say, $8,000 to $20,000 per day, this is an expensive proposition. Substantial investment in handling and loading facilities will be necessary to change this situation, and in the meantime, demand continues to grow. Much export coal sold from the U.S. is under short term contracts. This, plus the cash-squeezed position of most U.S. railways who own the current coal loading facilities, is not conducive to investing in expensive and risky capital-intensive facilities.

The rightmost column of Exhibit 5 provides estimates of the average costs of handling coal in the various terminals. These figures are less publicised than estimates of rail and shipping costs and should be accepted with some caution. In fact, a range rather than precise figure is given. These cost estimates do not include demurrage charges associated with ship delays.

Port handling costs are not nearly as high as rail and shipping costs. The absolute variation among ports is also lower than rail and shipping costs (although the variation is probably as high on a percentage basis). Australian ports tend to be more costly than others. This could be explained either by higher costs of construction or pricing policies followed by port authorities.

Exhibit 5 contrasts a number of other features of major coal loading ports. Because both trade volumes and port capacities are increasing in most ports, these figures become outdated quickly. Of special interest are the comparisons of stockpile capacity and number of coal types handled.

D. Ocean Transportation

Coal is a bulk product of relatively low value and amenable to mechanised loading and unloading. It is a cargo which lends itself to large volume shipments to take advantage of economies of size in ships. The average ship size has increased significantly over the years although not nearly as much as crude oil tankers. However, the ability to exploit the economies of ship size is often constrained by draft limits in export and/or import ports. In addition, there are size constraints imposed by the Panama and Suez canals for many trades.

The ocean shipping of coal constitutes a significant portion of the final delivered price of coal, often comparable to the size of rail freight charges. Anyone familiar with shipping markets will know that shipping rates are notoriously unstable, flucuating in accordance with innumerable changes in world economic conditions. For example, fluctuations in single voyage charter rates from Hampton Roads to Japan aboard Panamax size vessels varied from $8 to $25 per ton between early 1979 and early 1980. This is not an unusual variation. Rates have fallen significantly during the past year as new bulk ships have come on the market at a time when the world economy still faces recession.

However, only a small part of world coal trade travels under voyage or trip charters. The vast majority of trade (85 per cent plus)[6] is moved under long term contract so the actual costs of moving coal reflect the long run average costs of owning and operating the ships.

H.P. Drewery's Shipping Consultants have recently published an in-depth report which reviews current and projected costs of ocean transport of coal on various routes by various ship sizes. These costs estimates reflect non-North-America flag ships and average bunkering (fuel) costs. These estimates exclude the loading and unloading costs (but do include port charges and the costs of time in port). Four ship sizes were examined: 40 MDWT, 65 MDWT (panamax vessels), 120 MDWT (to represent current large vessels in this trade), and a 175 MDWT vessel to represent the larger vessels which are expected to ply the coal trades in the future.

Exhibit 6 lists the daily costs of owning and operating these vessels in 1980 $US. Ownership and fuel costs are the two largest items in total vessel costs. Exhibit 7 lists the required freight rate or long run average costs including a normal return on investment (in the current depressed ship market, charter rates would be less than the figures in Exhibit 7). It is clear that certain countries have definite advantages in reaching particular markets. Australia and Western Canada are roughly equal distance from the Japanese market. New coal ports on the west coast of the United States will also be competitive in shipping distance. The U.S. east coast is much closer to the European market than the other long distance suppliers (but Poland is even closer). South Africa faces distances to Europe greater than that from the U.S.

The cost estimates per tonne for various ship sizes and routes in Exhibit 7 are intended to be a guide toward the long run costs of shipping coal but some important caveats must be mentioned. The first row for each port are the costs operating in one direction (calculated by H.P. Drewery's, 1981). But these costs are incurred jointly on behalf of the fronthaul and backhaul. If backhaul traffic could be loaded instantly then the one direction costs might be a reasonable estimate of long run costs. But even this is an arbitrary allocation of joint costs; the competitive (and economically efficient) prices would reflect the relative value of service of demands for movement in the two directions.

If there is no return cargo then the fronthaul market must bear the full costs of the return trip. These were estimated by adding the value of ship's time (average daily ownership cost and operating costs including fuel) for the return journey. The 100 per cent empty return figures are a slightly high estimate because fuel consumption at sea while in ballast is not as high as when fully laden.

It may be possible to reduce the proportion of time in ballast by engaging in indirect routings, e.g., triangular trades. To estimate vessel costs in this situation the practice is to calculate the total percentage of time in ballast and apportion the costs of this empty running time in proportion to the various loaded distances travelled by the vessel. Once again, this is a totally arbitrary allocation of costs; efficient prices for the multiple trades would reflect the relative ability to pay among the trades. Nonetheless, these allocations of costs can be instructive about the potential costs of carrying coal on particular routes.

The important point is that the availability of backhaul traffic, either direct or via indirect routing, varies among coal trading routes. A route with little opportunity for backhaul traffic will face significantly higher ocean transport costs than routes with profitable backhauls. A corollary, of course, is that success at cultivating backhaul traffic could be vital to the ability to penetrate some markets.

Exhibit 7 includes an estimate of coal shipping costs based on various assumptions about the availability of backhaul traffic. For example, both Australia and Western Canada are a long distance from European markets. But the Australian route has greater opportunity for backhauls. For example, after unloading in Europe, ships could ballast to the U.S. east coast and load coal to Japan, and from there ballast back to Australia. Alternatively, OBO's could carry Mid-East oil or a load of ore to Japan or possibly direct to Australia. Several other bulk movements from Atlantic to Pacific regions are also possible. Backhaul prospects for ships carrying coal from Western Canada are not so promising. OBO's could load north African oil for the U.S. but that still leaves substantial ballast sailing. Lee (1978) provides some estimates of backhaul probabilities. Using these estimates of "ballast ratios" we obtain additional estimates of the costs of shipping coal over various trade routes. Incorporating the differential backhaul possibilities makes ocean transport of coal from Australia to Europe cheaper than from Western Canada despite comparable distances involved.

One final caveat to these estimates of backhaul opportunities or ballast ratios concerns the massive increases in world coal trade which are being projected. These will not necessarily be accompanied by increases in other trades. Hence the current availability of backhaul cargoes might not be a reliable guide to the future availability of such cargoes. Indeed, if the coal trade really booms as many predict, a more realistic estimate of shipping costs on many routes, and especially for trades using the largest vessels, would be to assume 100 per cent empty returns.

The estimates of shipping costs do not include the costs of demurrage if ships are delayed loading or unloading coal. Delays at unloading ports are infrequent but are a serious problem at some loading ports. The U.S. east coast ports have the most serious problems as the demands placed on the infrastructure are very heavy and the complex scheduling arrangements for numerous coal types from different buyers further complicate the situation. Delays of 30 days per ship are common.[7] This can add as much as $10 to the cost per ton of shipping coal, $4 to $8 are more typical. Coal ships also find waits frequently are necessary at New South Wales' ports. Again, the volumes of coal demanded place severe strains on the existing transport system. For example, berth utilisation at Port Kembla is on the order of 90 per cent (personal interview) with no relief until the new loader and stockpiles are in operation. Even then it will continue to be a very busy system. The waits at New South Wales' ports are not as large as in the U.S. Waits of 16 to 21 days per ship were typical in 1980-81 (see footnote 5).

E. The Significance of Transport Costs for Long Distance Coal Suppliers

As stated at the outset, there are a number of factors which affect market shares besides transportation: mining costs, qualities of coals, reliability of supply, government taxation and similar policies, environmental concerns, etc. In equilibrium there will be an inverse relationship between the size of the total transport bill and marginal mining costs. That is, high transport cost suppliers will not be able to develop high cost mines. Considerable variation in the mine-site value of coal can be found among various countries and among mines for any given country, and part of this variation reflects differences in costs of transporting coal to overseas markets.

In this paper, attention is concentrated on the influence of transport costs in the final delivered price independent of possible variations in mining costs. For this reason an arbitrary value of (U.S.) $30 per tonne has been taken as indicative of the mine site value of coal. Actual mine site coal prices in the world are both above and below this figure. This method of calculation results in different delivered prices of coal where the differences are explained solely by transport cost differentials.

Exhibit 8 summarises the relative importance of the various transport cost components from alternate suppliers. It should be noted that the transport cost estimates are incomplete. Not calculated are the costs of unloading, storing and transshipping coal at overseas destinations. For the most part these will not vary much among alternate suppliers so these transport cost components can be set aside for this discussion.[8] But these neglected transport cost components could add several more dollars to the final delivered price of export coal.

The figures in Exhibit 8 showing the size of transport costs to the overseas ports make use of the assumed empty ballast ratios for ships reported in Exhibit 7. Figures are for panamax size vessels as well as the largest size vessel (175 MDWT; 120 MDWT for U.S. east coast ports). Ship demurrage costs are also included. The bottom rows summarise the size of total transport costs relative to a c.i.f. value based on a mine-site value of $30/tonne.

Canada is a high cost supplier into Europe.[9] New South Wales experiences similar transport cost levels but this is due to current limits on ship size and demurrage charges. Comparing Canada to Queensland, Canada's total transport bill to Europe would run $6 to $13 per tonne higher. South Africa

can deliver coal to Europe cheaper than from Queensland by several dollars per tonne. The U.S. is no cheaper than Queensland but this reflects the limits on ship size in U.S. ports and, especially, demurrage charges.[10] The complex shipping and scheduling arrangements in the U.S. which aggravate the ship delay problem are being revised. Reducing ship delays will improve the U.S.' competitiveness in coal transportation costs. Increased port storage to enable unit train movements could reduce rail rates and further improve the U.S. situation.

Canada is more competitive in the Far East than in Europe although transport costs from Canada are slightly higher than from Queensland or South Africa. Again, ship size limits and demurrage costs place New South Wales at a slight disadvantage in terms of total transport costs to the Japanese market. New infrastructure and other investments will improve this . The U.S. east coast is at a serious transport cost disadvantage to Japan; new west coast ports will change this considerably. (However, the quality of coals available from the west may not be as valuable as the high quality coking coals from the U.S. east coast).

The high transport costs from Canada relative to other suppliers comes as no surprise. But specific transport cost comparisons are fairly rare. The figures presented here should be useful for contrasting the variation in transport costs among the various suppliers.

F. Transportation Cost Trends and Future Market Shares

The remaining task is to review trends in transportation costs and their potential implications for prospective market shares of coal suppliers.

But first a few caveats are in order. Transportation is a major portion of the final delivered price of coal, hence differential changes in transportation costs from may affect market shares. However, there are many other factors which affect coal sales and some are more important than transport costs. Important factors are the price of coal at the mine (which reflects mining costs and royalties paid), reliability of supply, and various quality attributes of the coal. Flucuations in exchange rates could be significant. The adequacy of port and transportation infrastructure is important as is the record of industrial disputes or other sources of disruption to the coal supply chain. All of these are important, perhaps more important than changes in relative transport costs among countries. But they are not the interest of this paper. The purpose here is to draw attention to trends in the components of total transport costs and the potential implications for prospective market shares in future world coal trade.

1. Rail Transportation -- The prices of capital, labour, fuel, and other inputs are expected to drift upward with inflation in all countries. Most expect fuel prices to increase faster than the rate of inflation. Ceteris paribus, this prospect is more serious for a long distance supplier with adverse terrain -- sound familiar? On the other hand, fuel is only one component of total transport costs, and Canada is relatively better off than Australia and South Africa in terms of the long term availability of fuel supplies.

Capital investments are a major item in the rail transportation of coal. Ceteris paribus, greater capital investments are required by countries with the longest routes from mine to port. The necessary expenditures on rail capacity in western Canada have been well publicised. These are underway. Major rail track and structure investments are also needed in most other coal suppliers, especially in New South Wales. South Africa plans to double track the main line to Richard's Bay. All countries will need extensions to serve new mines and ports.

Another cost item which may be of increasing importance is track maintenance and repair. It is well known that track wear and replacement has increased far beyond initial expectations when unit coal trains first began to move. This is costly both as a direct expense and in terms of the need for increased track time for maintenance and repair. These expenses fall most heavily on the longest lines and those which are the most congested. On a related matter, there is increasing concern that the current maximum size car (100+ net tons or 263,000 lb. gross) may be above optimal size. If so, there may be a costly gradual fleet replacement in the future.

Finally, there may be potential for a general increase in productivity of rail systems. Given the right opportunity, incentives, and management, productivity gains through innovative operations might be a possibility. However, the Canadian rail systems are acknowledged to be "lean" and efficient in comparison with rail systems elsewhere in the world. The point for Canada is that there probably is little scope for squeezing out much "fat" from the Canadian rail system. Nor are radical innovations on the horizon. Hence there is little prospect of achieving an additional competitive edge in the world coal trade via reductions in rail transportation costs other than by a squeeze on rail profits. Like Canada, Queensland and South Africa already operate large unit train operations for coal exports, hence there is limited prospect for reducing rail costs there either. Some railways face limitations on performance which are inherent in characteristics of the coal logistics system, e.g., short hauls, lack of space for stockpiles at port, traffic congestion with limited space for double-tracking. Various institutional characteristics are important too, such as restrictive regulations, a shortage of investment capital, or obsolete managerial practices. The countries with the greatest potential for reducing rail costs would be the U.S. east coast lines and those of New South Wales. Expanded and/or upgraded track, equipment, and port facilities would enable more efficient operations.

2. Port Investments -- Major investments in port facilities are needed to cope with increases in coal trade. Major investments are forthcoming in all the major coal suppliers. Similar investments in coal-importing countries are also necessary. Draft limitations are especially important. South Africa and Canada will be able to handle the largest of vessels with little or no additional investment. Hay Point, Queensland is also well equipped although significant dredging costs may be necessary if vessel sizes continue to increase. The rest of Australia and the U.S. face more sizeable expenditures for dredging to accommodate large vessels. But, as mentioned, the problem of draft constraints is more serious in importing ports. There are far more importing than exporting ports and it is not economic to provide deep draft in all of them. Major transshipment ports such as Rotterdam may play an even more important role in the future.

Another factor in ports is stockpile capacity. This is an especially serious constraint in U.S. east coast ports; it is also a handicap in most Australian ports, especially in New South Wales.

3. Shipping Costs -- One dominating fact complicating the life of shipowners has been the dramatic rise in the price of fuel. Of course, fuel price increases have hit all modes but it is ironic that the most fuel-efficient mode has been hit the hardest. The reason is that ships burn a very low grade of fuel. There is little processing cost imbedded in their fuel price. In contrast, gasoline and aviation fuels have much higher processing costs embodied in their delivered price. These latter costs have not increased as rapidly as the raw material. Practically the full increase in wellhead price flows through to the price ships pay for bunkering. Shipowners have faced fuel cost increases of several hundred per cent, and prices have shot up dramatically again during the past year (although they may be declining somewhat just now). Fuel costs have gone from a relatively minor expense to about 40 per cent and more of total shipping costs. If fuel prices continue to rise the implications for shipping costs are obvious. Ceteris paribus, this falls more heavily on long distance suppliers and those with poor backhauls. Canada's prospects are not good here. Canada can compete in the Japanese and Far Eastern trades, but continued increases in ship bunkering costs would adversely affect prospects for penetrating the European trade.

Bigger and newer ships might help in this regard, especially for long distance suppliers. Canada has the deep water ports to be able to take advantage of larger ships. However, as mentioned, these possibilities are limited because many trade routes face draft restrictions in importing ports or canals. Newer more fuel efficient ships would help offset the higher fuel costs. But there is a glut of bulk ships on the market and it will take years before a significant portion of the world fleet is replaced by more fuel-efficient vessels.

4. Conclusion - The conclusion can only be of a very general nature. Transportation costs are a major component of the final delivered price of coal to overseas markets. Canada faces significant transportation obstacles in competing for coal export markets. Canada's success in the world coal trade reflects high performance in overcoming the transportation challenge: highly efficient rail systems have overcome significant geographic handicaps, and these combine with efficient high-volume port facilities with deep drafts to enable the use of large ships. There is not much which can be done to further reduce transportaiton costs for Canadian coal. In contrast, there is room for improvement and cost reduction in transportation for some of Canada's competitors, notably the United States and New South Wales, Australia. In brief, Canada stands at a disadvantage concerning transport costs and future expansion of the world coal trade, especially to Europe.

Nonetheless, it would be incorrect to conclude on a negative note. Canada does appear to be at a transport cost disadvantage. However, it is obvious that, despite the importance of transport costs in the final delivered price of overseas coal, transport costs are <u>not</u> the dominant factor explaining success in the coal export trade. Mining costs are important but probably more important are various quality attributes of coal and reliability of supply. This paper cannot elaborate on these factors but only point out their general importance. Canada's future success in the coal trade will continue to depend on maintaining our efficient transportation system, but competitive successes at the margin are probably to be found through aggressive marketing which stresses the quality attributes fo our coal and, especially, reliability of supply to foreign buyers.

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Because this paper grows out of a larger research project which has benefited from input by dozens of people, it is impossible to acknowledge all those who have contributed through discussion and comment. But I do wish to thank the following for their helpful comments and conversations specifically in prpearation of this paper: Terry Garvey of B.C. Coal, Trevor D. Heaver of U.B.C., Graham Kedgeley, the B.C. Coal Coordinator, and Don McDougald of Swan-Wooster Engineering Company. Of course, the author bears full responsibility for the final product.

FOOTNOTES

1The title of the recent World Coal Study (WOCOL), 1980.

2The reduction in coal requirements for coking purposes has been partly due to the introduction of some oil injection into blast furnace processes. Higher oil prices may make increased use of coal more attractive.

3Phillips and Peckham, 1980, p.8.

4Figures in Exhibit 4 become out of date quickly. Rail charges are increasing everywhere. It is likely that rail rates in Australia have increased more rapidly than in other countries (e.g. 17% in New South Wales in 1981, Australian Financial Review, 14 January 1981). This reflects government policy in both Queensland and New South Wales.

5Government of New South Wales, Hansard, 9 April, 1981.

6H.P. Drewery's, (1981), p.78.

7John L. Jacobs Co (1981), p. 11, reports average delays of 40 days in the first quarter of 1981.

8The unloading and transshipment costs could vary for different suppliers depending on distances involved, possible multi-port itineraries, shipment size, possible draft limits or other size constraints, etc.

9Potential coal exports to Europe from eastern Canada could be much more competitive in terms of transport costs.

10Some lay days are allowed in shipping contracts hence demurrage actually charged will reflect less than the total days waiting. But ship's time has value and ultimately is paid for whether as demurrage or higher charter rates. The cost estimates for ships presented in Exhibit 7 do not include an allowance for lay days. Therefore the allowance for demurrage in Exhibit 8 are slightly higher than the actual amounts paid to shipowners as demurrage.

Appendix: Sources of Information

This paper draws on a much larger study of "Logistics Management and Coal Exports". A considerable amount of material has been gathered for that study which is not cited specifically in this paper. Some information which is particularly hard to come by has been pieced together by cross-checking several different sources, often too numerous to mention. The following is not a complete list of sources but it includes those which have been the most helpful in pulling together material specifically for this paper, especially concerning railways and ports.

Australia -- information on rail operating conditions has been compiled by personal interview as well as via various public documents. Especially useful are materials from the World Coal Study (WOCOL) both volumes I and II, and the New South Wales Coal Export Strategy Study, 1979.

Rail rates generally are not public. Queensland rates were based primarily on figures reported in the Bulletin (Australian Financial Times), 25 Nov., 1980. New South Wales' estimates are based on figures reported in the Australian Financial Review, 14 January, 1981, cross-checked with figures reported in H.M. Lee (1980) and other sources.

Operating characteristics of Australian ports are primarily from the Joint Coal Board, Black Coal in Australia, 1978/79 and 1979/80. This was supplemented by material for WOCOL, both Volumes I and II, as well as by personal interviews.

Canada -- Rail rates are individual contracts with mines but rates are well known. Information on rail and port operations from a number of sources including direct interviews.

Republic of South Africa -- The major sources of information are the "Area Review -- South Africa" in Bulk Systems International, March 1980, plus H.M. Lee (1980) and interviews with people knowledgeable about the South African operations.

United States -- the main sources of information are materials reported in WOCOL, Volumes I and II as well as the U.S. Dept. of Energy, Interim Report of the Interagency Coal Export Task Force, 1981, including various background studies prepared in conjunction with this study especially Vol. 12, Background Study on Ports and Inland Transportation.

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Exhibit 1

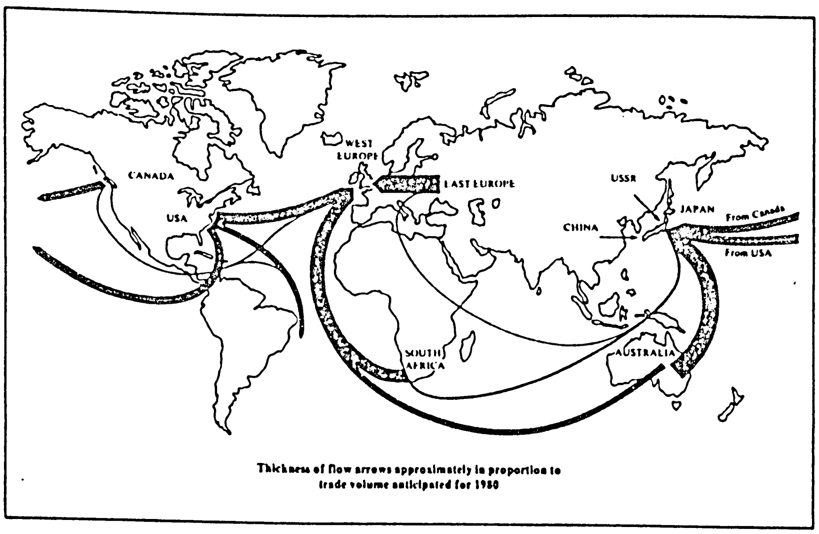
World seaborne trade in coal 1979 ('000 tonnes)

Exports to:	ECC	Scandinavia	Other West Europe	Japan	South Korea and Taiwan	South America	Others	Total	Percent of total Exports
Australia	7416	—	768	26,931	3972	171	1132	40,390	26.0
S Africa	13,550	—	350	2375	926	16	5362	22,579	14.5
USA	16,709	881	2688	14,226	999	3478	3219	42,200	27.1
Canada	1045	164	328	10,730	991	522	55	13,835	8.9
Poland	15,329	4538	2141	495	—	1350	647	24,500	15.7
USSR	2685	500	—	2365	—	—	—	5550	3.6
Others	3930	316	133	2090	—	—	—	6469	4.2
TOTAL	60,664	6399	6408	59,212	6888	5537	10,415	155,523	
Percent of total Imports	39.0	4.1	4.1	38.1	4.4	3.6	6.7		

Source: Cargo Systems Research/Consultancy Division, Bulk Systems International, "Coal: The Best is Yet to Come" (June, 1980) pp. 8-10.

Exhibit 2

Pattern of World Seaborne Coal Trade, 1980



MAJOR ROUTES OF SEABORNE COAL TRADE

Source: Canada West Foundation, Western Canada's Coal: The Sleeping Giant (Calgary) 1980, p. 123.

Exhibit 3

Resources, Reserves, Production, Exports and Export Potential of Major Coal Producing Countries (mtce)[a]

Country	Geological Resources	Technically and Economically Recoverable Reserves	1977 Production	1977 Exports	WOCOL export expectations by 2000
Australia	600,000	32,800	76	38	160
Canada	323,036	4,242	23	12	27-47
People's Republic of China	1,438,045	98,883	373	3	30
Federal Republic of Germany	246,800	34,419	120	14	23-25
India	81,019	12,427	72	1	5
Poland	139,750	59,600	167	39	50
Republic of South Africa	72,000	43,000	73	12	55-75
United Kingdom	190,000	45,000	108	—	—
United States	2,570,398	166,950	560	49	125-200
Soviet Union	4,860,000	109,900	510	25	50
Other Countries	229,164	55,711	368	7	25-50
Total world	10,750,212	662,932	2450	200	550-700

Source: WOCOL , Vol 1, pages 22, 36, 161.

[a]mtce = million metric tons of coal equivalent, i.e. measured in terms of coal with a heat content of 12,600 BTU/lb. (7000 kcal/kg)

Exhibit 4

Railway Rates and Operating Conditions, 1980

	Queensland, Aus.	New South Wales, Aus.	W. Canada	South Africa	United States (E. Coast)
Rail Freight Rates (approx., 1980 $US, per tonne)	$ 5.00 - $10.50	$ 4.50 - $ 9.00	$13.00 ±	$ 6.00 ±	$12.50 - $15.00
Basis for Freight Rate	value of service	tonne - km formula rates well above costs	value of service	contract rate (cost plus?)	limited rate freedom, cost-based tonne-mile formula plus markup
distances	50 - 350 km	10 - 320 km (70 - 130 typical)	1150 km±	600 km ±	600 - 650 km
cars/train, railcar capacity	148 cars @ 58 tonnes; 60+ cars @ 50 tonnes (to be 100 cars) (3'6" guage)	17 cars @ 78 tonnes; to increase to 30 and 42 cars	100± cars @ 92.5 tonnes	84 cars @ 58 tonnes; will increase to 92 cars (narrow guage)	cars @ 72.5 tonnes (multiple car movements, i.e., not unit trains)
grades and terrain	moderate grades	escarpments force circuitous and steep routes on some lines	harsh mountain terrain, grades, slides, washouts and severe weather	moderate grades	moderate grades
traffic conditions	congestion limited to a couple sections	heavy congestion on many lines despite double and even 3 & 4 tracks	congested single track operations	largely dedicated line, to be double-tracked	largely dedicated lines, congestion near yards
rail ownership	department of state government	department of state government	private company and independent public enterprise (federal)	government department	private companies plus independent public enterprise (Conrail)

Sources: See Appendix

Exhibit 5

Selected Characteristics of Major Coal Loading Ports (metric tonnes)

	amount loaded 1979, 1980	annual capacity MMTPY	nominal stockpile capacity	approx. number of coal	nominal loading rate	max. ship size (MDWT)	ownership	expected capacity 1985	1980 cost per ton (approx.) US$
Australia									
Queensland									
Haypoint (2 berths)	14.8	20	2.5	few	6000 4000	150	private, state gov't adm.	+20 (gov't)	$3.00+
Gladstone 2 terminals + 1 in 1980/81	3.4 3.4 .2	8 5 10	.4 .3 .6	?	1600 to 4000	55+	local harbours board & state gov't	+26	?
New South Wales									
Newcastle 2 terminals	11.9 11.9	4 12 (PWCS)	.09 1.0	40+	2000 & 4000	58	state gov't port, 1 private terminal	25	$3-4
Port Kembla	7.0	7.5	.3	20+	2000	58	state gov't	14	$3.00+
Canada									
Roberts Bank	10.2	12	1.2	8	7600	150	Federal port, private terminal	20+	$2-3
Neptune Terminals	3.9[a]	6-7	.6	3	4000	90	Federal port, private terminal	no change	$2-3
Prince Rupert	—	—	—	—	—	—	Federal port, private terminal	10	N.A.
South Africa									
Richards Bay (2 berths)	22.6[b]	25+ (increasing)	2.8	13	6500	150+	gov't port, private terminal	44	$1-2
United States (E. Coast)									
Hampton Roads (4 terminals)	21.2[a] 7.9[a]	{26.3 {3.6 {15.C {4.8	store in rail car (6-7000) cars	980+	7400 8200 & 1350 1500 6500 7200 & 2050 2250	80 to 40+	state port private (railway) terminals	+ 6.3 + 1.9 — + 4.5	≤$1.00
Baltimore	8.3[a]	15.1	store in rail cars (1500)	many	5000	70	port authority, private (railway) terminals	+15.9	$1.00+

[a]1980, [b]1979

Exhibit 6

Daily Vessel Costs
(US$, per tonne, 1980)

	vessel size			
	40(MDWT)	65(MDWT)	120(MDWT)	175(MDWT)
ownership cost[1]	$ 8597	$ 9826	$13560	$17196
daily operating cost including overhead[2]	4526	5314	5820	8143
fuel cost/day, at sea	$10038	$13608	$15097	$17247
in port	2658	3488	3877	4267
Total cost/day - at sea	$23161	$28748	$34477	$42586
in port	15781	18628	23257	29606

Source: H.P. Drewery Shipping Consultants, Ocean Shipping of Coal, Survey No. 24, October, 1981, pp. 92, 94 and 97.

[1]Includes 10 percent return on investment, 80% of purchase price financed at 8% for 8½ years, 15 year life and zero salvage value.

[2]Includes manning. stores, repairs and maintenance, insurance and administration.

Exhibit 7

Estimated Unit Cost of Transporting Coal

By Ship Size and Trade Route: 1980

(US Dollars per Tonne)

LOAD PORT	DISCHARGE PORT	PERCENT BALLAST RETURN	VESSEL SIZE 40 MDWT	65 MDWT	120 MDWT	175 MDWT
Hampton Roads	Rotterdam	0	8.40	7.10	5.80	-
		100	14.60	10.95	8.35	-
		65%*	12.05	9.60	7.45	-
	Japan**	0	21.20P	17.70P	16.40	-
		100	38.60P	26.50P	27.15S	-
		65%P; 50%S	32.50P	24.05P	21.80S	-
Roberts Bank	Rotterdam	0	18.70P	14.90P	14.80M	13.10M
		100	34.30P	24.55P	25.35M	21.80M
		75%P; 90%M	30.40P	22.15P	24.30M	20.95M
	Japan	0	10.20	8.10	6.60	6.40
		100	18.35	13.15	9.95	9.15
		100*	18.35	13.15	9.95	9.15
Richards Bay	Rotterdam	0	14.10	11.0	8.20	7.50
		100	26.45	18.65	13.25	11.65
		70%*	22.73	16.35	11.75	10.40
	Japan	0	15.20	12.20	9.10	8.50
		100	23.30	20.30	14.50	12.95
		75%*	25.00	18.30	13.15	11.80
Hay Point	Rotterdam	0	24.50S	19.10S	13.60S	12.60C
		100	45.70S	31.70S	21.95S	20.85C
		45%S; 40%C*	33.65S	24.80S	17.35S	15.90C
	Japan	0	9.30	7.70	6.20	6.00
		100	16.45	12.15	9.15	8.40
		100*	16.45	12.15	9.15	8.40
Newcastle	Rotterdam	0	25.40S	20.10S	14.60S	-
		100	45.85S	32.80S	23.00S	-
		(not est.)*	-	-	-	-
	Japan	0	10.70	9.10	7.60	-
		100	18.50	13.95	10.80	-
		(not est.)*	-	-	-	-

S = Suez Canal
P = Panama Canal
C = Cape of Good Hope
M = Cape Horn (Magellan Strait)

Source: HP Drewery Shipping Consultants Ltd., Ocean Shipping of Coal, Survey No. 24, October, 1981. Their figures were calculated with zero empty return; the above figures include the costs of ship's time and fuel on return voyage.

* estimates of ballast return from H.L. Lee, "The Long Run Economics of Ocean Transport of Coal", IEA Coal Research, London (Dec. 1978).

** Fukuyama, Japan

Exhibit 8

Summary of the Relative Size of Transport Costs
to Foreign Ports
from Major Suppliers
(1980 U.S. $ per tonne)

		Queensland	New South Wales	W. Canada	South Africa	U.S. (E. Coast)
Rail Rates		$ 5.00 - $10.50	$ 4.50 - $ 9.00	$13.00	$ 6.00	$12.50 - $15.00
Handling Cost in Port		$ 3.00+	$ 3.00 - $ 4.00	$ 2.00 - $ 3.00	$ 1.00 - $ 2.00	$ 1.00 - $ 2.00
Ocean Shipping Costs [a]	Europe (65 MDWT)	$24.80	$25.80[b]	$22.15	$16.35	$ 9.60
	(175 MDWT)	$15.90	—	$20.95	$10.40	$ 7.45[c]
	Japan (65 MDWT)	$12.15	$13.95[b]	$13.15	$18.30	$24.05
	(175 MDWT)	$ 8.40	—	$ 9.15	$11.80	$21.80[c]
Ship Demmurage Charges		—	$ 3 - 8	—	—	$ 5 - 10
Total Transport Costs	Europe (65 MDWT)	$33 - 39	$36 - 45	$37 - 39	$23 - 25	$28 - 37
	(large vessel)	$24 - 30	—	$36 - 37	$17 - 19	$26 - 35
	Japan (65 MDWT)	$20 - 25	$24 - 35	$28 - 30	$25 - 27	$42 - 50
	(large vessel)	$16 - 22	—	$24 - 26	$19 - 21	$40 - 48
Transport Cost as percent of c.i.f. value (for mine value of $30 per tonne)	Europe	44 - 57%	55 - 60%	55 - 57%	36 - 45%	46 - 55%
	Japan	35 - 46%	44 - 54%	44 - 50%	39 - 47%	57 - 65%

[a] estimated ballast ratios as reported in Exhibit 7

[b] ballast ratio same as for Queensland

[c] maximum ship size of 120 MDWT assumed