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The international coal trade pattern

by

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Abstract

Climate policies may reduce the coal demand in some of the major coal importing countries (e.g., Western Europe and Japan). This paper analyses how a shift in the import demand for coal will affect the trade pattern in the international coal market. The following issues are covered: a) Is coal a homogenous good in the sense that it is easy for coal importers to switch between suppliers in different countries? b) Is the USA still a swing supplier in the world coal market, as claimed by Ellerman (1995), or are other countries taking over this position? c) How are trade patterns influenced by shipping freight rates?

We find that a) importers increasingly blend their own coal composite and thus may switch between suppliers more easily than before, b) USA's position as swing supplier in the steam coal market has declined and c) a trend toward shorter transport distances prevailed in periods with falling freight rates.

1. Introduction

There are large differences in transport distance between various coal exporting countries and the respective importers. Therefore, in order to assess the impact of changes in coal import demand on the demand for transport, it is important to know how volume changes will be distributed across the exporting countries. In order to address this question, we first need to know whether the differences in coal qualities that exist between the various exporters are important for the demand pattern, or whether these quality differences do not play an important role once coal prices are adjusted accordingly. This question is addressed in Section 2. Our findings suggest that there has been a change in the handling of coal quality by the power industry. Whereas quality previously was important for the chosen supplier, power stations have now shifted to composing their desired quality by mixing coal qualities imported from several sources. The relative prices for different coal qualities and the transport costs influence the components chosen in the blend used by the individual power stations. Similarly, the link between coking coal and the steel industry is weakened following the introduction of Pulverised Coal Injections (PCI) technology that opens up for the use of non-coking coals in blends used in producing pig iron.

Given that considerations about coal quality do not tie the trade pattern to specific countries, we would expect that changes in trade volumes would affect countries in accordance with their marginal costs of coal supply. High cost suppliers will be brought into the international trade as import demand surges, while they will leave the market as demand recedes. In a much cited article, Ellerman (1995) argues that the USA plays the role as a swing supplier in the international coal market. This view has recently been challenged by the IEA (2001), arguing that the USA coal industry has reoriented towards the domestic market, thus making it less likely that the USA will take the role as a swing supplier in the future. This issue is further discussed in Section 3. We find that the role of USA as the residual supplier of steam coal has declined.

The international coal trade constitutes an important part of the world dry bulk markets. In 2001, 565 million tonnes of coal entered seaborne trade. This represented

42 per cent of seaborne trade in the main dry bulk commodities; i.e. coal, iron ore, grain, bauxite, alumina and phosphate. Changes in coal transport demand therefore impact on freight rates. At the same time, transport costs make up a significant share of the CIF[1] costs of import coals. Due to the large differences in transport distances between various coal exporters and the import markets, the changes in freight rates may therefore in themselves be a source of restructuring of the international coal trade patterns. In Section 4 we find that the average distance traded culminated in 1987. By the end of the 1990s the average distance was shorter than in the 1970s. This we explain by (1) changes in trade pattern towards shorter hauls following an increase in intra Asian trade, together with a shift in Australian exports from Europe to Asia, and (2) increased use of blending by important coal importers that enables more geographically efficient sourcing of coal.

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[1] CIF-prices imply prices including cost of coal, insurance of the cargo and freight cost for coal delivered at the plant.

2. Coal quality

Coal qualities differ among the producing areas. Consumers of coal will be limited in their choice of suppliers if their production processes require specific qualities of coal. If so, this influences market structure and trade patterns. We know that for example electricity plants are built for specific coal qualities and that they traditionally have used sources that could supply these qualities irrespective of changes in relative prices for different coal qualities or changes in relative transport costs for coal originating in different locations. In this chapter we will point at current changes in coal consumers' dependence on specific coal qualities.

The International Energy Agency (IEA) divides coal into hard and brown coal based on calorific value. Hard coal has a higher calorific value (> 23.9 Gj/t) than brown coal. Both steam and coking coal are hard coal qualities. Brown coal does not enter international trade among OECD countries. Hence, hard coal dominates the seaborne coal trade. We have seen a sharp increase in steam coal in international seaborne trade, whereas traded volume of coking coal increase more slowly.

Besides the differences in the calorific value, coal qualities also differ on moisture, ash content, volatiles and sulphur contents. IEA illustrates the variations in quality used for selected producers in 20 countries (IEA, 2001 p I.95). In table 2.1 we have extracted information from IEA to exemplify the variation in blends used in the power plants. We list variations in six basic quality elements for a sub group of power plants; calorific value, moisture, ash, volatile matter, and sulphur content. Thus, the quality characteristics for coal are rather complex. This implies a potential for power plants in composing the specific blends.

Table 2.1 Example on the variation in quality of steam coal used in electricity production

Ranked by required calorific vale	Country	Calorific value (kcal/kg)	Moisture %	Ash %	Volatiles %	Sulphur %
Upper	Money point Ireland	6450-7400	12 max	11 max	32 main	0.75-1.70
Intermediate	Denmark (indicative)	5770	10	15	28	1.5
Lower	Catalagzi Turkey	3390	20	35	16	0.53

Source: IEA (2001, p. 95)

The major consumer of steam coal is the electricity producing industry. About 90 % of the steam coal demand in the OECD countries is used in electricity production. As seen above, coal for electricity production varies widely in quality. Most power stations are designed for a specific coal quality, however. Blending different qualities to meet the design coal characteristics for the power plant has become normal. Whereas electricity producers traditionally used specific qualities supplied by a few sources, power plants now increasingly blend different coal qualities and adjust the composition according to changes in relative CIF-prices for the individual qualities. Both relative prices for different qualities and relative transport cost influence the decision on the components chosen to produce the desired blend. The increased flexibility in the choice of coal inputs has induced a reduction in the share of long-term coal contracts and the correspondingly rising share of spot and short-term contracts. Copenhagen Amagerværket can be used as an example. They blend steam coal qualities to compose the optimal quality for their power plants. Blending allows them to buy coal from diverse sources in order to minimize the total costs of coal and freight. The power plant chooses input to minimize CIF prices.[2]

Coking coal is used mainly for producing coke. This implies a strong link between coking coal and the steel industry. Technological changes have weakened this link, however. Coke producers either get coking coal from a single mine or base their production on a blend of different qualities. In addition non-coking coals may be included together with coke in the process. The use of Pulverised Coal Injections

[2] Source; Åge Fagerholt København Amagerværket interviewed November 2002.

(PCI) in pig-iron production started in the 1980s, and has opened up for using lower quality coal in a blend with higher qualities. The PCI technology also opens up for the use of a wide range of coal qualities with respect to volatility.

As pointed out above, power plants now increasingly blend their own input, and hence may switch suppliers reflecting changes in relative CIF-prices. Since more users now compose their required coal qualities, it is necessary to study the geographic spread of the main qualities, both for steam and coking coal, given that the qualities produced in a specific geographic location may differ from that of another location. Steam and coking coal are spread out geographically, the possibility to switch inputs when composing the required blends thus seems better than if only a few areas supplied each kind of coal for international trade.

In table 2.2 we list the main producers and their exports. We find that several countries produce and export steam coal. Coking coal is produced and exported by the same producers. Brown coal is produced in several of these countries, but rarely enters international trade. The figures show that the broad coal qualities; steam and coking coal, are produced by all the major coal exporters. The qualities do not merely differ by country, but also by extraction sites within a country. To illustrate this point we report some examples of variation in heat content of coal from different sites in some of the major export countries in table 2.3 below.

Table 2.2 Production and export of coal (Million tonnes)

Main exporters	Production				Export		
	Hard coal	Steam coal	Coking coal	Brown coal	Hard coal	Steam coal	Coking coal
Australia	223.7	125.9	97.8	67.3	169.9	83.9	86.0
South Africa	223.5	221.9	1.6	0.0	66.2	66.2	
USA	916	862.3	53.7	78.4	56.7	27.6	29.1
Canada	36.5	8.1	28.4	36.0	33.6	4.6	29.0
Colombia	32.7	32.3	0.4	0.0	29.9	29.9	0.0
Indonesia	72.0	72.0	0.0	0.0	54.5	54.5	0.0
China	1238.3[3]	1115.1[4]	123.2	0.0	37.4	32.2	5.2
Poland	110.2	87.9	21.4	60.8	24.1	17.5	6.6
Russia	152.4	97.5	54.9	82.7	27.7	21.3	6.4
Czech Republic	14.3	6.3	8.0	44.8	6.1	2.6	3.5
Germany	43.8	20.0	23.8	161.3	0.2	0.2	0.0
World	**3666.5**	**3154.4**	**509.3**	**877.5**	**547.3**	**379.1**	**168.2**

Source: IEA (2001)

Table 2.3 Variations in heat content

Export area		**Heat content GJ/t**	
		min	**max**
Australia			
	Queensland	27	28
	NSW	26	28
Canada			
	Western Canada	25	30
Colombia			
	Cerrjon region	25	28
Indonesia			
	Kalimantan	27	28,5
South Africa			
	Transvaal	25	27
Venezuela			
	Guasare	29	30
United States			
	Appalachia North	28	30
	Appalachia Central	28	30
	Appalachia South	26,5	29
	Powder river basin	19,5	20
	Uinta basin	27	29

Source: IEA (2001) table 6.17

[3] Including production of lignite (brown coal)
[4] Including production of lignite (brown coal)

Since several coal consumers now use a variety of coal qualities in composing a blend close to the design coal quality for their plants, we may conclude that the available coal quality does not significantly restrict the choice of supplier. This contrasts with the situation before blending became widespread and indicates that the structure of international coal trade and transport has become more competitive than before these changes in operations emerged. On the other hand the substitutability is not perfect and importers still seem to have a limited number of suppliers to choose among.

This conclusion is supported by the findings in a paper on coal shipping and the blending problems facing power plants in Taiwan (Liu and Sherali, 2000). They model the optimal shipping and blending decisions for twelve power plants. All major coal-exporting countries are included in their analyses i.e. Australia, Indonesia, Canada, South Africa and USA with 13 different suppliers operating in these locations. They list differences in quality specifications on sulphur oxide, ash, calorific value, volatile mater, grindability index, moisture content and nitrous oxide for the coal supplied from each source. The variations in the characteristics are seen from table 2.4 below. In their model five of the power plants blend coal from three sources, five plants compose their input from coal delivered by two suppliers and only two plants use an unblended coal quality.

Table 2.4 Variations in quality specifications for coal supplied by the 13 different sources.

Sulphur oxide (%)	Ash (%)	Calorific value (kcal/kg)	Volatile mater (%)	Grindability index	Moisture content (%)	Nitrous oxide (%)
0.45 - 1.11	4.51-15.2	6.6 - 7.0	25.75-42.22	46-58	7.26-12.30	0.10-1.12

Source: Liu and Sherali (2000) table 2.

3. Is there a swing supplier?

Which of the coal exporting countries will accommodate any changes in the coal import demand from Europe and Japan? The first place to search for an answer to this question would be in the data on coal supply costs. We would expect that high cost suppliers would be the last to enter the market as demand and coal prices rise and the first to leave the market when coal demand slumps and prices fall.

Table 3.1 Steam coal average unit import values, CIF, US$/tonne, 2000

	Japan		Western Europe	
	Import price	Import market share	Import price*	Import market share
Australia	34.59	58.1	39.20	7.3
Canada	34.72	1.6	45.84	0.3
United States	45.49	3.8	41.24	3.9
South Africa	35.82	2.0	33.74	32.9
Russia	30.68	3.9	33.68	7.9
China	33.69	16.4	31.45	2.4
Poland	-	0.0	35.32	13.9
Colombia	-	0.0	34.23	17.8
Indonesia	n.a.	13.1	n.a.	6.6

* *Import prices are for EU15 only.*
Source: IEA (2001).

Tables 3.1 and 3.2 show that the USA is the most expensive source of imported hard coal both to Japan and Western Europe. Canadian steam coal is admittedly more expensive than US coal in the European market, but the Canadian market share is very small (0.3%). Based on these figures we would therefore expect the demand for US coal to be the first candidate for a reduction. This is in line with the arguments set out by Ellerman (1995) that the USA has the role as a swing supplier in the international coal market.

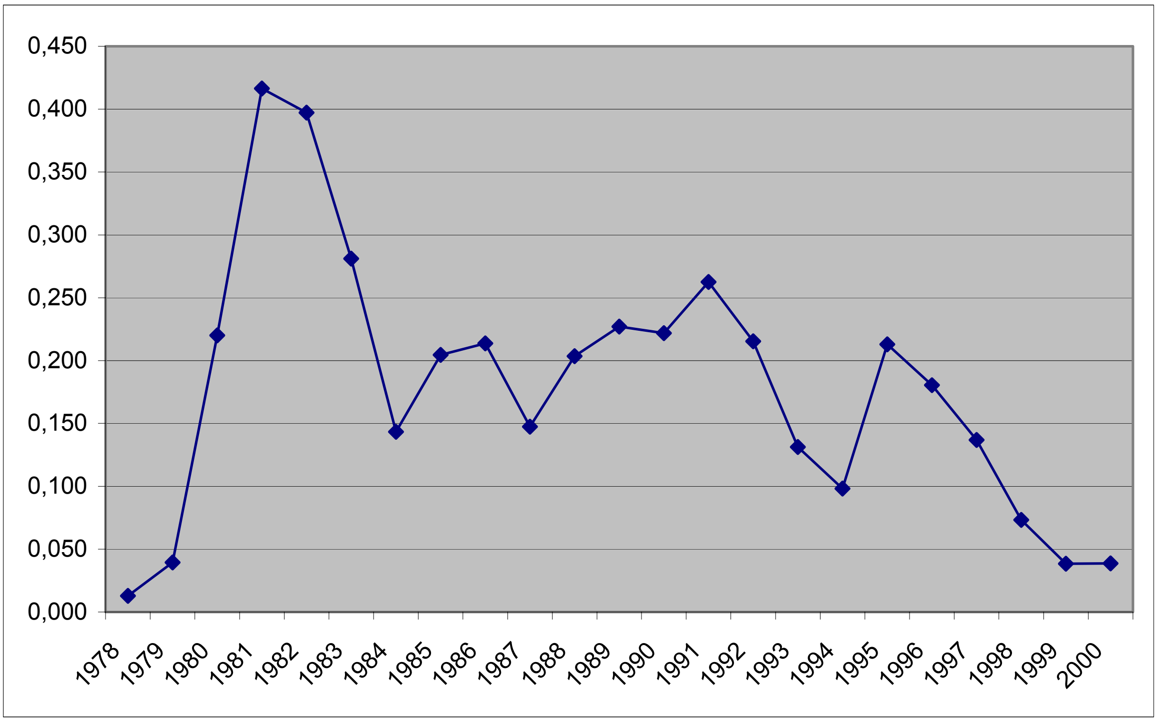
Table 3.2 Coking coal average unit import values, CIF, US$/tonne, 2000

	Japan		Western Europe	
	Import price	Import market share	Import price*	Import market share
Australia	39.01	60.0	45.47	34.6
Canada	45.46	21.6	45.99	12.5
United States	52.69	3.3	52.91	36.5
South Africa	39.99	0.9	39.09	1.6
Russia	43.62	3.5	42.03	0.5
China	37.12	3.8	n.a.	0.6
Poland	-	0.0	50.52	9.7
Indonesia	n.a.	5.6	n.a.	2.4

** Import prices are for EU15 only.*
Source: IEA Coal Information (2001)

However, this does not mean that the US role in the coal market is the same as it used to be. While the USA has always had a weak market position in the Asian market, the current low market shares in the European steam coal market marks a new development. From the mid 1980s to the mid 1990s, the US share of European steam coal fluctuated between 15 and 25 percent. But after 1995, the market share has fallen continuously to the current level of 3.9 percent. This of course implies that the USA can no longer accommodate any big fall in European coal demand; the level is simply too low at the outset. Hence, at least on the downside, the US role as a swing supplier is no longer as evident as it may have been before.

Figure 3.1 US Import market share in Western Europe, steam coal



Source: IEA (2001)

In the European coking coal market, however, the USA is still the leading exporter with a market share of 36 percent. Therefore, the USA may still absorb the downs in the coking coal markets. Hence, the US role in the coking coal market may differ from its role in the steam coal market.

There are several problems with the price data used above to discern between high and low cost coal producers. First, the prices are per tonne of coal and therefore do not reflect differences in heating values and other quality differences among coal exporters. Moreover, average data do not reflect differences among different mines within a country. Despite a high average price, individual mines may be very competitive in the international market.

In order to deal with these problems, table 3.3 provides estimates of the range of supply costs from different exporting regions, both measured per tonne and per unit of energy. The figures have been calculated based on the presumption that all differences in CIF prices are due to difference in heating value, which is not necessarily correct in all cases.

The figures suggest that even though the USA still appears to be a high cost supplier, Australian steam coal prices in Europe seem to match the US price level when the prices are adjusted for heating content. Thus, Australia also appears to be a swing supplier candidate in the European steam coal market. In the Japanese market, however, US steam coal has a clear disadvantage vis-à-vis Australian coal due to higher transport costs.

When it comes to the coking coal market, the IEA data on indicative coal export costs do not include information about relative heating values. But there are data on the cost ranges from some important mining regions.

Table 3.3 Price variations (CIF) per tonne and per unit of energy. Steam coal, 2000.

	Europe per tonne		Europe per unit of energy		Japan per tonne		Japan per unit of energy	
	Low	High	Low	High	Low	High	Low	High
USA								
Appalachia, North	34.0	41.7	36.4	41.7	42.0	49.6	45.0	49.6
Appalachia, Central	40.8	49.8	43.7	49.8	49.1	58.1	52.6	58.1
Appalachia, South	35.4	47.9	40.1	49.6	27.0	39.5	30.6	40.9
Powder River Basin, via Gulf	31.6	33.1	48.6	48.4				
Powder River Basin, via West					23.4	32.3	36.0	47.3
Uinta Basin					36.0	41.2	40.0	42.6
Australia								
Queensland, surface	37.5	41.9	41.7	44.9	31.3	35.7	34.8	38.3
NSW, underground	36.5	44.0	42.1	48.0	22.0	29.5	25.4	32.2
NSW, surface	39.5	46.1	43.9	49.4	25.0	31.6	27.8	33.9
Other exporters								
Canada	27.0	35.3	32.4	35.3	34.4	42.7	41.3	42.7
Colombia	29.9	41.1	35.9	44.0				
Indonesia	36.2	41.7	40.2	43.9	24.3	29.8	27.0	31.4
South Africa	31.9	42.0	38.3	46.7	22.1	32.2	26.5	35.8
Venezuela	29.1	36.6	30.1	36.6				

Source: IEA (2001). Prices per unit of energy are normalised to heating values of 30 Gigajoules) per tonne coal.

Table 3.4. Price variations (CIF) per tonne. Coking coal, 2000.

	Europe		Japan	
	Low	High	Low	High
USA				
Appalanchia, underground	48.3	56.6	56.6	64.8
Appalanchia, surface	53.4	56.5	62.1	65.3
Australia				
Queensland, underground	55.0	61.4	48.8	55.2
Queensland, surface	51.5	61.9	45.3	55.7
NSW, underground	54.0	60.0	39.5	45.5
NSW, surface	48.5	53.0	34.0	38.5
Other exporting countries				
Canada	34.3	42.5	41.7	49.9
South Africa	47.1	49.8	37.3	40.0

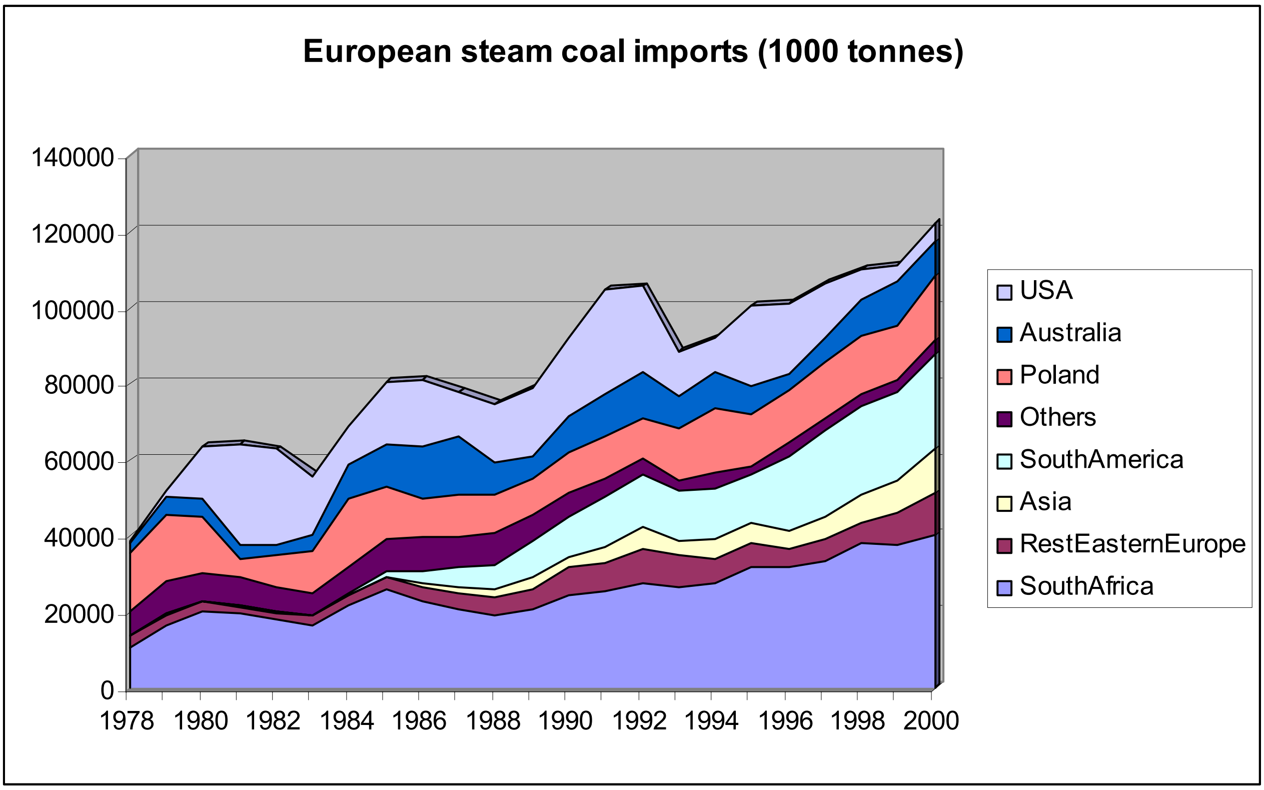
Source: IEA (2001).

These data display a somewhat different picture than the aggregate data in table 3.2. Whereas the USA on average sells the most expensive coal to Europe, Australia seems to be the most expensive import source at the margin. It may therefore well be that a small reduction in the import demand for coking coal in Europe will hurt Australian exporters more than the US ones. In the Japanese coking coal market, on the other hand, it seems quite clear that the USA is the marginal supplier.

We conclude that the USA is the marginal supplier in the Japanese coal market but that, in Europe, the costs of Australian producers are comparable with the costs of US producers, both in the steam coal and in the coking coal markets. Note however that the analysis so far has not covered all exporters to the European market. In particular, the role of Poland in the European coal market needs some further attention.

In order to shed further light on the issue at hand, we will look into historic data on the coal trade patterns of Western Europe. Figure 3.2 shows the development of Western European steam coal imports by source.

Figure 3.2 European steam coal imports (1000 tonnes)



Source: IEA (2001)

There appears to be an underlying positive trend in European steam coal imports, but there are also considerable fluctuations around the trend. This data series therefore seems well suited to draw some further inferences about the response of the trade pattern to fluctuations in import demand. Figure 3.2 indicates that most exporting countries have a quite smooth development in their export volumes. But two countries, at least, appear to display a somewhat higher variability; the USA and Australia. This is in line with what we would expect from the cost analysis above.

In order to draw more robust conclusions, we conduct some simple statistical analysis. First, we measure the variability in the respective export volumes. We hypothise that export from each of the countries will vary around a linear trend in accordance with the development in aggregate import volume and proportionally with each of the countries' share of total imports. Based on this hypothesis, we construct a measure of the "predicted" exports for each of the exporting countries. We then measure the standard deviation around the predicted export levels. High variability for one of the exporters shows that the export levels vary more than we would expect based on the variability of aggregate import volumes and may indicate that this country is a residual supplier. But supply side factors may of course also explain changes in export volumes. In order to uncover such effects, we calculate the coefficient of correlation between actual exports and aggregate imports. We would expect residual suppliers to show a high, positive coefficient of correlation. The results are shown in Table 3.5.

Table 3.5. Analysis of variance

	Standard deviation around predicted trend	Coefficient of correlation with aggregate imports
Australia	0.36	0.25
Rest Eastern Europe	0.62	-0.47
South Africa	0.09	-0.06
Asia	0.31	-0.23
South America	0.20	-0.03
Others	0.31	-0.14
Poland	0.32	-0.56
USA	0.44	0.35

The results confirm that imports to Europe from both the USA and Australia display relatively high volatility, at the same time as the variations are positively linked with the aggregate import figures. There are also other regions with relatively high variations in the export figures, but the correlation coefficient with aggregate imports is strongly negative, suggesting that this variation is probably due to supply side factors. We take this to confirm our previous results that the USA and Australia are the major residual suppliers in the European steam coal market. Notice however that there is a methodological problem here: It is more difficult to discern supply factors from demand driven factors for exporters with a large market share, because supply shocks will make a significant impact on aggregate import figures, thus increasing the probability that exports are positively correlated with aggregate imports.

Figure 3.3 Actual and predicted exports of steam coal to Europe from Australia

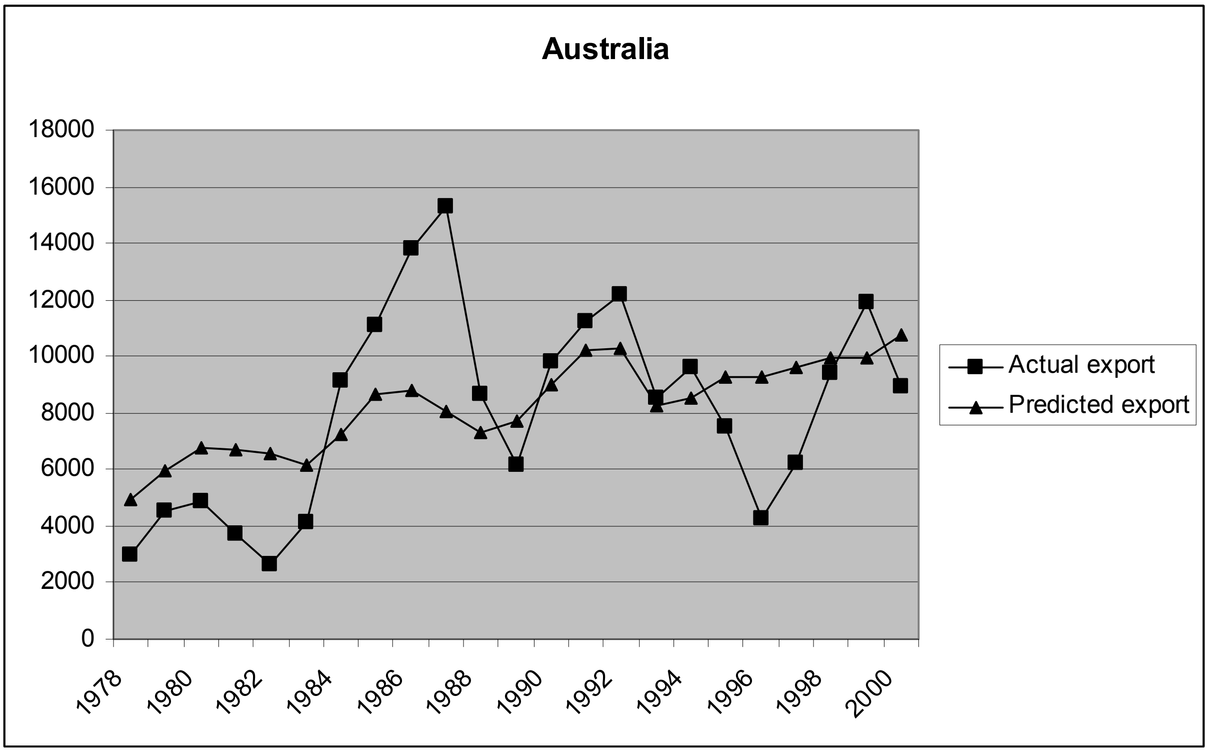
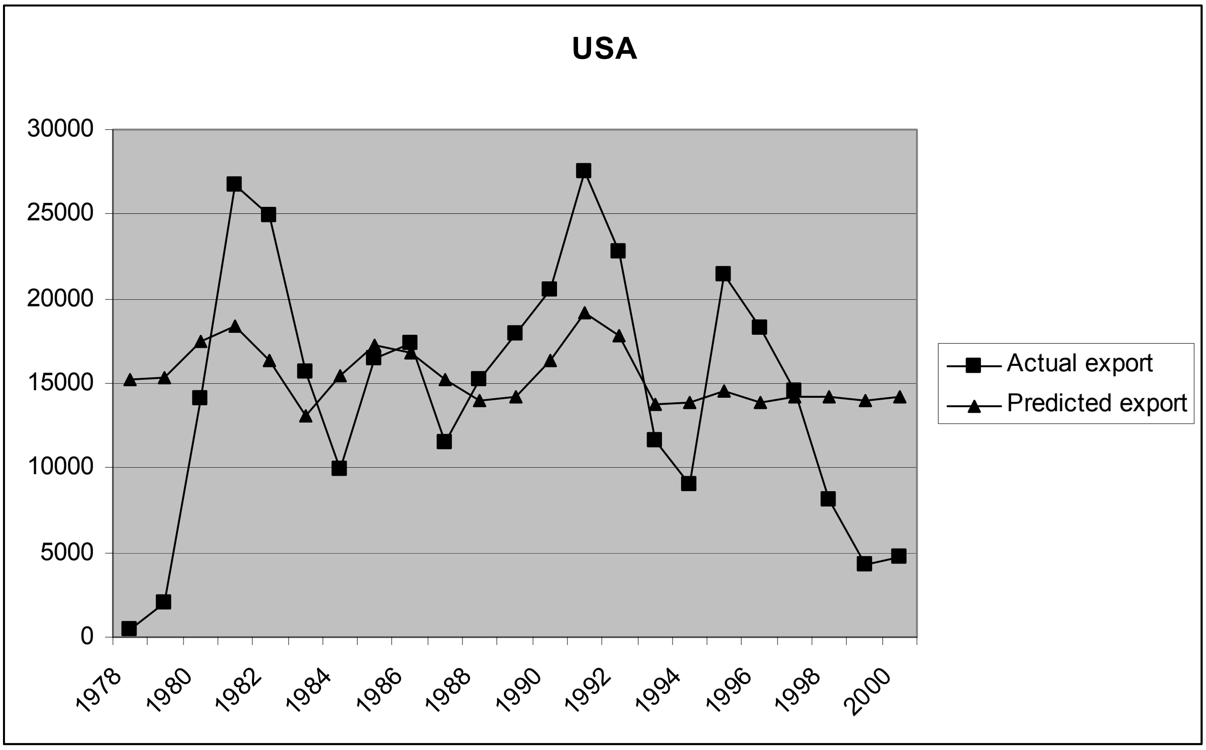


Figure 3.4 Actual and predicted exports of steam coal to Europe from the USA



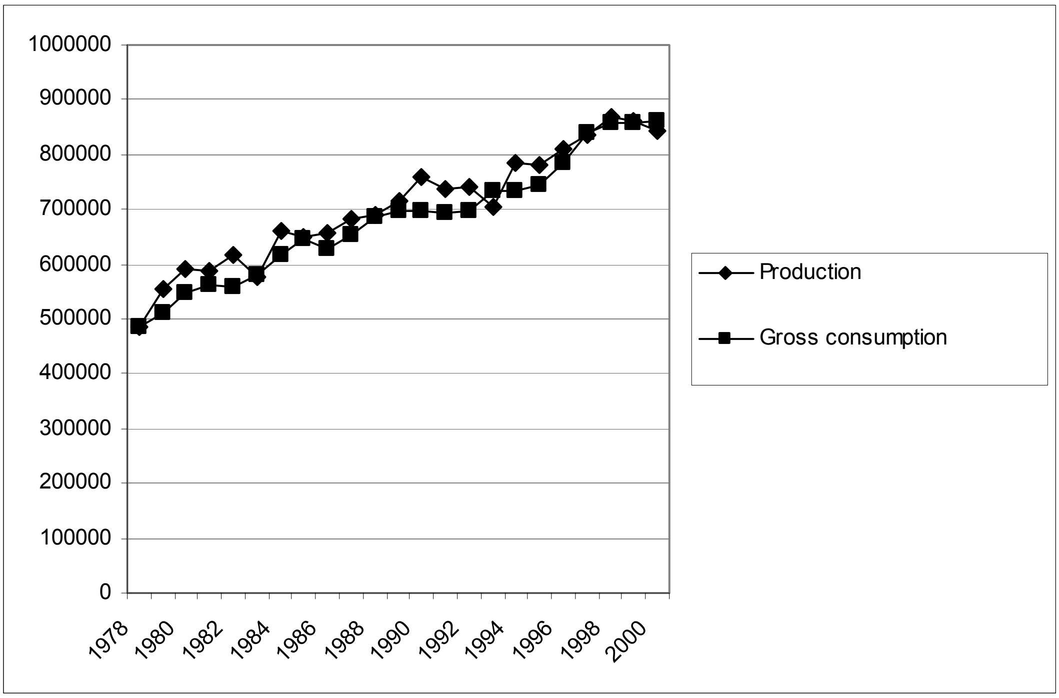
Figures 3.3 and 3.4 show the actual exports from Australia and the USA to Western Europe and the predicted export level, based on a linear trend that is adjusted for fluctuations in total European steam coal imports. The figures reveal that over most of the time period considered, the development in exports from these regions has shown high correlation with the predicted exports, and with a substantial degree of "overshooting", suggesting that these countries take more of their proportional share of the fluctuations in European import demand. This is what we would expect from a residual supplier.

But this pattern is less obvious after about 1995. Especially in the USA, there has been a marked decline in exports to Europe, much more than we would expect based on the trend development. What are the driving forces behind this development? Have there been structural changes in the US market that may imply that the low level of exports is more than a temporary phenomenon? In other words, is the role of the USA as a residual supplier not as evident as before also in the case of an upswing in the European coal market?

After 1995, there has been a gradual tightening of the domestic US steam coal market (see figure 3.5). Demand has surged, and although production has also increased substantially, the increase in production has not been as strong as the increase in demand. After 1998, demand has stagnated. Nevertheless, the market has continued to tighten, due to a declining level of production.

According to IEA (2001), there has at the same time been a structural shift of production in the USA towards regions that have a natural disadvantage in the production of export coal.

Figure 3.5 Steam coal balance in the USA



Source: IAE (2001)

Projections of future steam coal trade confirm that the declining role of the USA in the world steam coal markets is not expected to be just a temporary phenomenon (see table 3.6). The IEA projects that US exports will decline from 24.6 Mt in 1999 to 17.5 Mt in 2020. In the same period, Australian steam coal exports are projected to increase almost three-fold, from 73.4 Mt to 203.8 Mt.

Table 3.6. Projected steam coal exports (Mtce)

	1999	2005	2010	2020
Australia	73.4	88.6	103.7	203.8
United States	24.6	21.4	18.5	17.5

Source: IEA (2001)

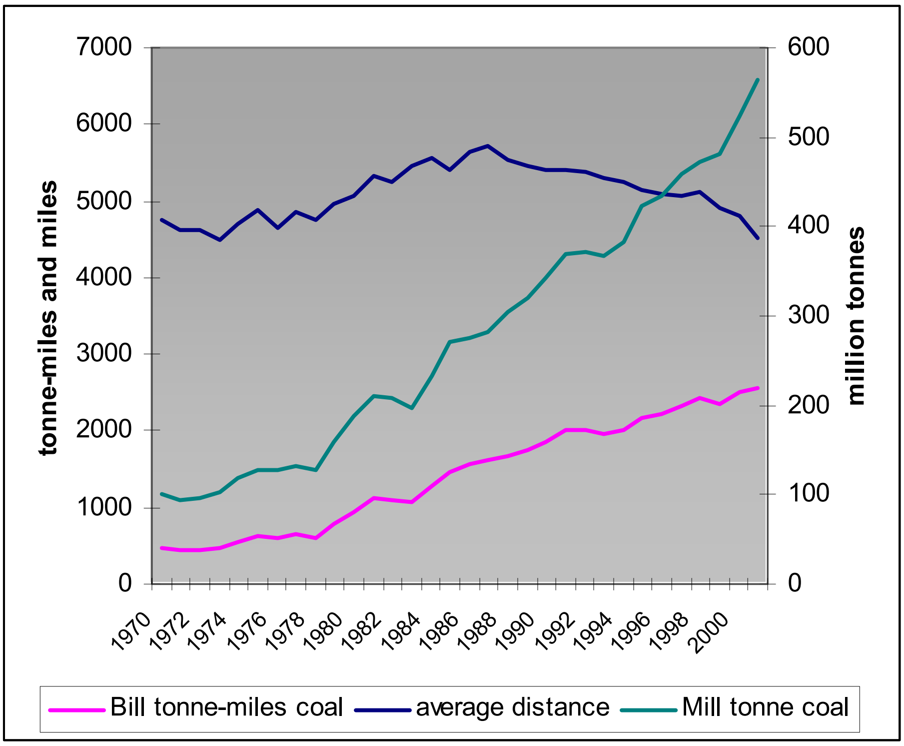
Thus, it seems that the role of the USA as a residual supplier in the world steam coal market will not be as pronounced in coming years as it was up until the mid1990s.

4. Coal trade and freight rates

Coal trade developments vary with changes both in volume (tonnes) and distance (miles). In this chapter we discuss importers' sensitivity to freight levels and the effect on their sourcing decisions. Such effects may be expected because transport costs make up a significant share of the CIF prices for coal. Traditionally transport costs have been more important for coal import prices than for example for oil. Relatively high transport costs for coal may strengthen any effort to reduce the dependence on far away suppliers.

Seaborne trade in coal has increased steeply during the last 20 years. As is seen from figure 4.1, the total volume of seaborne trade (million tonnes) nearly tripled. This follows from a strong growth in trade in steam coal combined with a somewhat more dampened growth in seaborne trade in coking coal. The transport work (tonne-miles) is a function of traded volumes and the distance. Transport work in the coal trade has increased but, especially in later years, at a lower phase than the rise in the traded volume. The difference is explained by the changes in average distance. The average distance traded increased markedly, from 4800 miles in the mid 1970s to 5700 miles at its maximum in 1987. Since then the average distance shrank every year to a level of 4400 miles in 2001, which is below the average distances at the start of the period. Such considerable changes in the average distance reflect substantial changes in the trade pattern. One important explanation for the rising distance before 1987 was Australia's increasing importance as a supplier to countries outside Asia. Imports to Europe from Australia more than tripled from 8 mill tonnes in 1982 to a maximum of 28 mill tonnes in 1987. (See figure 3.3 for variations in imports from Australia to Western Europe). Even though exports from USA to Europe fell for several years, this was not enough to dampen the growth in average distances before 1987.

Figure 4.1 Development in volume traded, transport work and in average distance in seaborne trade in hard coal 1970-2001



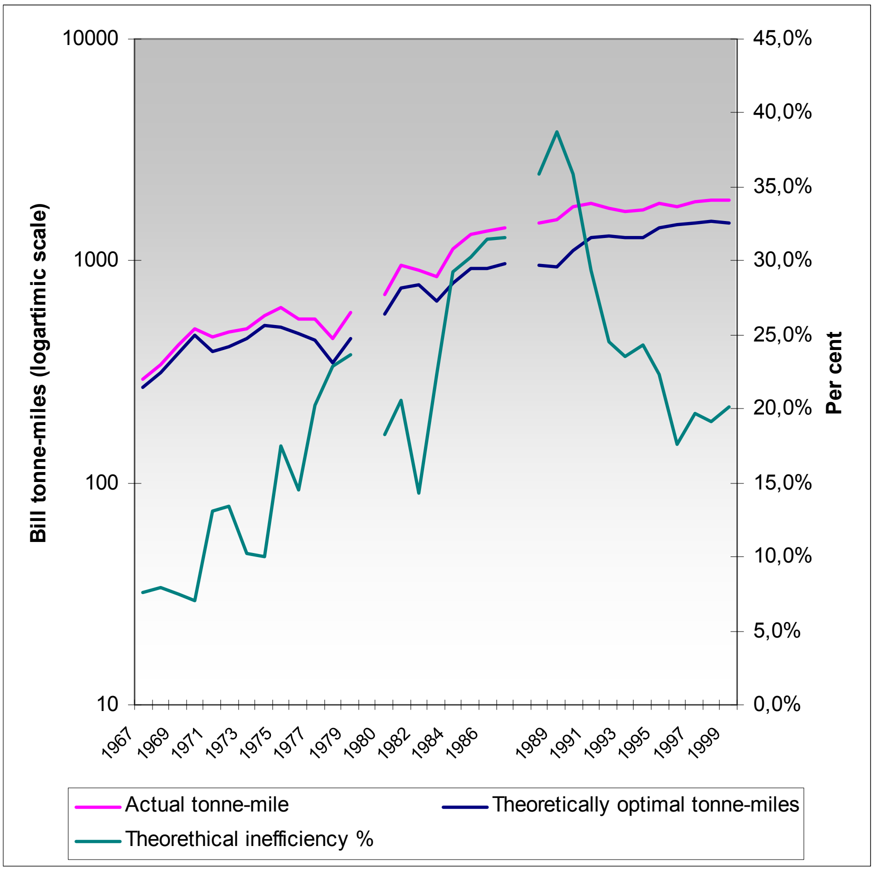
Source: Based on data in Fearnleys (2002)

From its maximum in 1987 the average distance in hard coal seaborne transport has fallen sharply. The effect on average distances from the reduced European imports from North America, no longer seems to be compensated by other developments. There has been a rise in intra-Asian trade in coal and a redirection of Australia's exports towards Asia that also reduce transport distances on average. Figure 3.4 above shows that imports from USA fell in most years after 1991. The positive trend in imports from Australia throughout the period (see figure 3.3) has not been enough to counteract the downward trend in average distance in the hard coal seaborne trade.

Changing distances imply that there is not a fixed relationship between the volume of coal transported and the transport work (tonne-miles) performed by the fleet. In addition to the obvious effects on distances from shifts in the trade pattern, the average distance traded may change from changes in routing for given import and export volumes in each region. Changes in routing may result when importers more systematically choose the nearest supplier. Differences in coal qualities among producers and limitations on port capacities have traditionally been used to partly explain why importers do not always use the nearest supplier.

To analyse how far the actual coal transport work deviated from the minimum distance that would result if every importer chose the closest source, Strandenes and Wergeland (1982) calculated the tonne-miles transport work when transport distances are minimized for the actual export and import volumes reported in each geographical location. The "inefficiency" thus signals the deviation from the optimal routing defined as the routing that minimizes transport distances in the trade matrix. The analysis disregards coal qualities and any restrictions on port capacities in either the exporting or importing regions. Hence, the actual trade pattern will never replicate this theoretically optimal trade pattern. Analysis of the *variations* in deviations from the theoretical minimum distances may contain interesting information, however. The theoretical inefficiency in the trade pattern fluctuates from year to year, as is seen in figure 4.2. Even so, the findings indicate a reduction in the theoretical inefficiency in the 1990s following a steep rise in the 1980s.

Figure 4.2 Coal transport efficiency



Source: Calculations based on data from Fearnleys World Bulk Trades and Fearnleys Review, several editions. The specifications in trade matrix used in the different periods 1967-1979, 1980-1987 and 1988-1999 differ and this is indicated by the gap in the time series. Data are reported in appendix 2. For calculations on the first period see Strandenes and Wergeland (1982), and for the second period see Strandenes, Weium and Wergeland (1990).

The reduction in average distance may reflect that importers have become less dependent on buying specific coal qualities since they may now blend coal from different sources to obtain a blend that complies with quality requirements for their the plants. Hence, importers now choose the trading partners more freely and thus reduce transport costs by a more active procurement policy.

When analysing the first period (1967-1979) Strandenes and Wergeland (1982) found a negative correlation between the freight level and deviations from the theoretical minimum distances. This is consistent with importers becoming more conscious of freight costs at high compared to low freight levels. A similar study (Strandenes, Weium, Wergeland, 1990) of the second period (1980-1987) did not confirm the negative correlation, though. Neither do similar analyses performed for the last period (1988-1999).[5] Thus, we cannot confirm that importers on average switch to more nearby suppliers when freight rates fall.

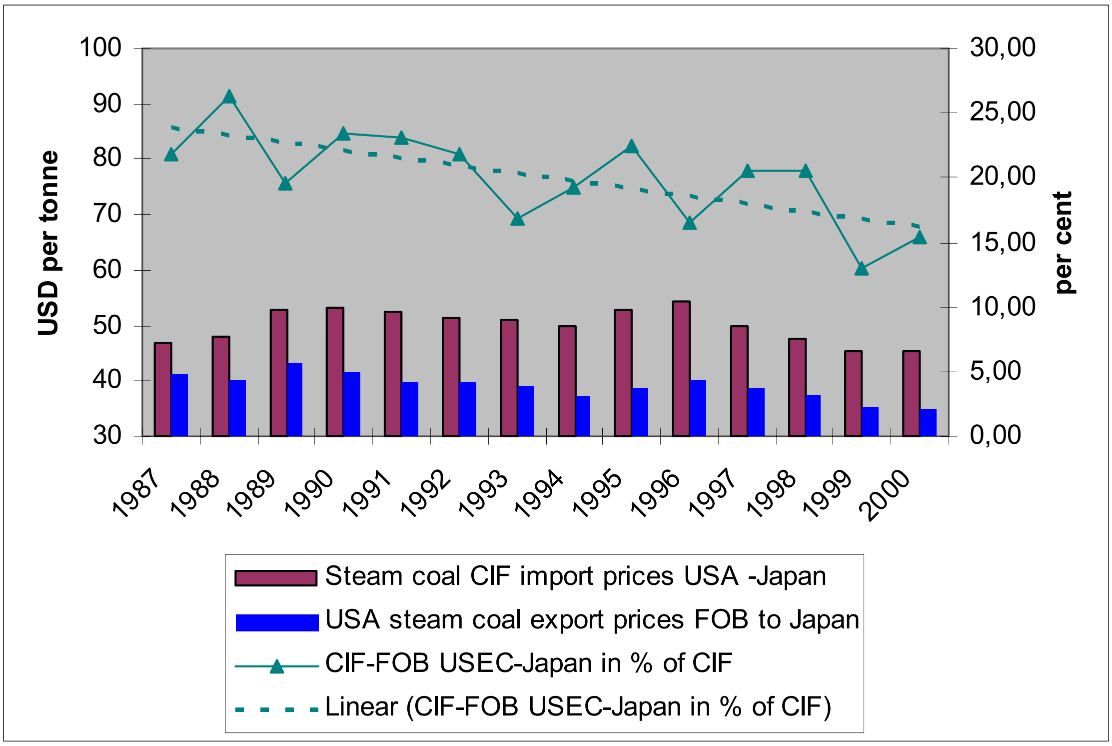
One possible explanation for this result is that new entrants in the coal market on average have chosen a more efficient trade pattern than the existing ones. Another explanation may be that better opportunities for blending have made it optimal to switch to more nearby suppliers in all regions, and that this effect more than outweighs any effect of lower freight rates. Thus, a more disaggregate analysis is needed in order to reject the hypothesis that there is a negative relationship between freight rates and trade distances.

In the correlations we used the spot freight for a specific route, i.e. US East Coast (Hampton Roads) – Japan, to represent the conditions in the spot freight market. Although *freight levels* differ among routes reflecting differences in trading distance, port cost and bunker prices, the *fluctuations in freight rates* are similar across geographical markets. Vessels move from one geographical area to another in response to changing market conditions across geographical market segments and thereby level out regional variations in freight levels. In the analysis we may therefore represent freight rates by a freight level for a specific route.

We know that transport costs may constitute a substantial part of the CIF cost for coal importing countries. For an example see figure 4.3 on steam and coking coal CIF import prices in Japan and the US-Japan freight rate. After 1987 the freight share of the CIF price has fallen from approximately 25% to about 15%.

[5] The data behind this analysis are available from the authors on request.

Figure 4.3 CIF and FOB prices for steam coal in the US-Japan trade



Source: IEA (2001)

Freight rates relative to coal prices differ among exporting regions, however. This may induce importers to shift to the more favourable sources and may increase the gains from flexibility in sourcing. In figure 4.4 we compare freight rate shares of CIF prices for imports to Europe from alternative exporters. With shares well above 10 percent in some cases and years it becomes clear why importers look for ways of reducing transport distances.

After 1980 both coal prices and freight rates reveal downward trends. Since the downward trend was stronger in prices than in freight rates before 1987, the freight cost element of the CIF import price to Japan increased in the first period. These relatively higher transport costs may have caused a steady focus on reducing transport costs and thus partly explain the increased use of coal composites.

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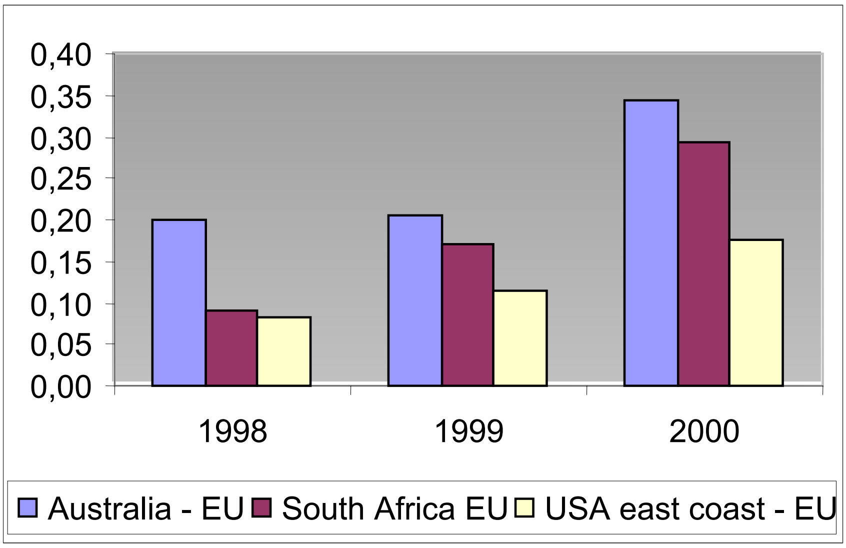
Figure 4.4 Spot freight rates relative to CIF prices for steam coal for imports to EU from alternative exporting areas.



Sources: CIF prices IEA (2001), Freight rate. Fearnleys Review several issues and Lloyds shipping economist.

We may conclude so far that even though spot freight rates relative to CIF coal price differ and transport cost may represent a significant share of procurement costs, we do not find a negative correlation between the freight level and average distance traded. The traditional explanations given for this result are coal quality requirements and port capacities. We have argued that coal qualities may set less strict limitations on the choice of coal exporter after the introduction of blends. Now we will discuss port capacities.

The capacities of dedicated coal port terminals vary. At the same time we know that almost any port may land coal cargoes irrespective of whether they have a dedicated coal terminal. The dedicated terminals are more efficient, but at a higher cost coal can be discharged in most ports. This implies that port capacities in importing countries are not strictly binding, even though bottlenecks may result in higher discharging costs and thus higher CIF prices, when the most efficient coal terminals cannot handle all the necessary cargo.

Figures 4.5 and 4.6 show port capacities and throughput in million tonnes per year for major importing and exporting areas, and the maximum vessel size that can be handled by their ports. We find that port capacities in USA, Australia and China are ample. Most exporting areas have at least one port that can handle large vessels of 150 000 deadweight tons (dwt) and the main exporters such as Australia, South Africa and USA have ports open to vessels of above 200 000 dwt. This pattern is similar for import ports in Western Europe and Japan. In Belgium, the Netherlands and Japan the capacity available was well above the throughput in the first quarter of 2000 and these ports can handle large vessels of above 250 000 dwt.

Figure 4.5 export port capacities and throughput as of 1st quarter 2000

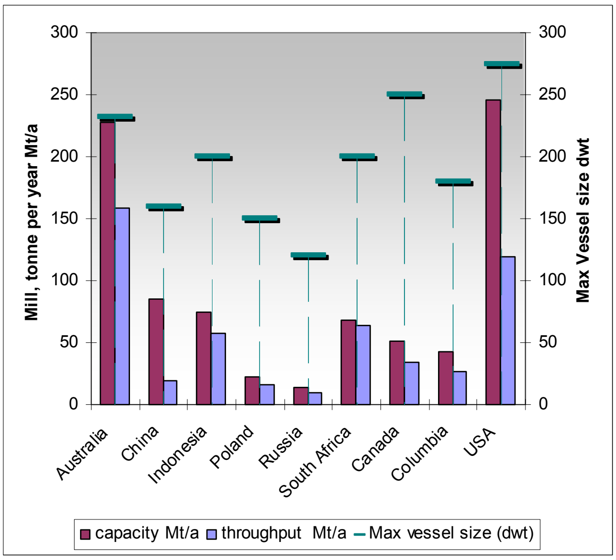
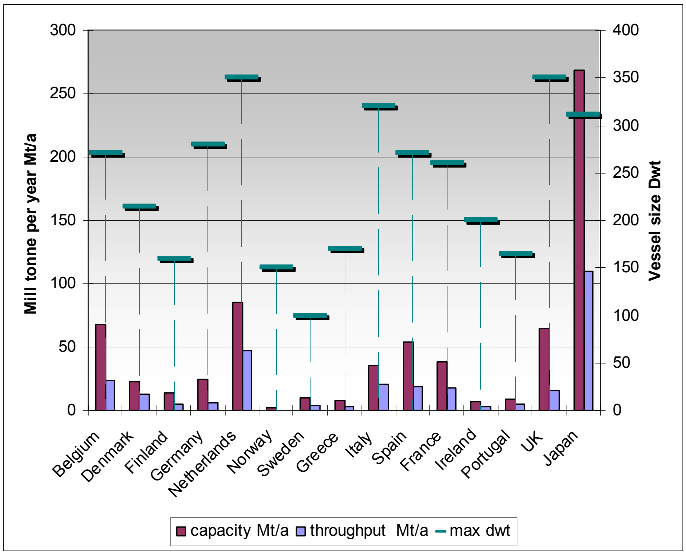


Figure 4.6 Import port capacities and throughput as of 1st quarter 2000



Source: IEA (2001)

This indicates that there is flexibility in the port capacities in most importing areas. The export port capacities are ample in the main exporting countries, but more limited in South Africa.

We have not looked into land transport in either the exporting or importing area. Land transport was the cause in one of the more spectacular incidents of capacity problems in world seaborne coal trade. In 1979 demand for coal rose sharply reflecting the hike in oil prices. The rise in coal demand caused serious congestion in Hampton-Roads (US East

Coast). In 1979-1980 bulk carriers waited long for cargoes because of congestion. The problem was not port capacities as such, but problems on the inland transport leg from the mine to the port. This indicates that flows may be temporarily hampered by sudden problems in the transport network.

5. Conclusions

In this paper we have studied three aspects of seaborne coal trade. Firstly we study the effects of the quality variations in coal. Different industries require different coal qualities. In later years blending to obtain the required coal composite has come into use. In addition technological developments such as Pulverised Coal Injections (PCI) allow for a wider spectre of coal quality inputs. We conclude that coal quality requirements set fewer restrictions on the choice of supplier than before. Consequently, the coal trade has become more competitive after these operational changes emerged. Even though substitutability in coal qualities has increased, it is still imperfect. Hence, importers have a wider choice in their sourcing decisions.

Secondly, we study whether there is a typical swing supplier in the coal market that will absorb fluctuations in coal demand to a larger degree than other exporters. We conclude that in Western Europe, both Australia and the USA have been acting like swing suppliers. After 1995, this pattern seems less obvious, though. In particular, structural shifts in the US coal industry may have permanently reduced the role of the USA as a swing supplier in the Western European steam coal market.

Thirdly, we study developments in trade flows and transport costs. We find that whereas the volume traded has increased sharply, the average distances in the coal trade have fallen significantly in the 1990s. Changes in the trade pattern following the increase in intra-Asian trade and the shift in Australia exports from Europe to Asia are significant for this result. The period is also characterised by an increase in the transport efficiency. The higher transport efficiency has pressed down the average trading distance further. We find that most export and import areas have ample port capacities, and this together with the higher flexibility from the increased use of blending, may explain this gain in the transport efficiency.

Our study does not confirm, however, that transport efficiency increases when transport costs rise and dampen when these costs fall. This result is contrary to findings in a similar study of coal transport efficiency in the 1970s (Strandenes and Wergeland (1982)). In the 1990s the freight rates had a negative trend, but transport efficiency still rose.

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