

The World Price of Coal

by

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ABSTRACT

A significant increase in the seaborne trade for coal over the past twenty years has unified formerly separate coal markets into a world market in which prices move in tandem. Due to its large domestic market, the United States has become the residual supplier and price setter in the world coal market. Changes in multifactor productivity have been the primary cause of the long-term fluctuations in coal prices that have been observed in the United States since the end of the Second World War and in the world coal market.

KEYWORDS: coal prices, productivity, energy markets

ACKNOWLEDGMENTS

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INTRODUCTION

The last two decades have witnessed the emergence of a world market in coal that is very different from the localized and specialized markets that existed prior to the 1970s. With the restructuring and integration of Europe, the price established in this market, the world coal price, will become the benchmark against which the restructured coal industries of Europe, East and West, will be judged. The world coal price will also increasingly become the standard against which other fuels, natural gas and fuel oil, that would compete with coal for the electric utility market, will be measured.

The purpose of this paper is not to provide an exact number, much less a projection of the world coal prices. Rather, it is to establish three basic propositions concerning the existence and formation of the world price of coal. In simplest form, the propositions can be stated as:

A unified world coal market exists.

The United States is the residual supplier and price setter for the world coal market.

Changes in coal mining productivity determine the trend of coal prices in the United States, and thus in the world coal market.

A UNIFIED WORLD COAL MARKET

The rapid expansion of the seaborne trade in coal over the past two decades has provided the vital link in unifying what had previously been separate domestic coal markets. Two factors are primarily responsible for the growth of the seaborne trade in coal. The first was the development, beginning in the late 1960s, of export-oriented mines, chiefly in Australia and Canada, to meet Japan's increasing needs for metallurgical coals and to reduce dependence on the United States. The second factor

was the sharp increase in oil prices during the 1970s which greatly expanded steam coal markets. Low oil prices before 1973 had severely restricted steam coals to markets close to the mines, but thereafter, when coal's high transport costs no longer seemed such a disadvantage, distant fuel oil markets were opened. The effect of these two factors is illustrated by Figure One which shows the doubling of the volume of internationally traded coal since 1970. Figure One also portrays the shift in the means of shipment as the market has expanded. Overland shipments, which had constituted forty percent of the total in 1970 are now reduced to about five percent, or twenty million metric tons of trade within Europe and between the US and Canada.

The world coal market does not yet include all world coal production, but only that part which is more or less freely traded and linked by the seaborne trade in coal. Presently, somewhere between a third and a half of the 3.5 billion metric tons of coal produced annually would be included in this category. Until now, the former Soviet Union, Eastern Europe, China, India and parts of Western Europe were separate and usually protected coal markets, only marginally linked to the world market; however, with restructuring, a larger share of world coal production will become part of the world coal market.

The world coal market encompasses both coking or metallurgical coal and steam or thermal coal. Coking coal is a special type of highly processed coal possessing certain chemical and mineral characteristics of value in the manufacture of steel, whereas steam coal comprises the more pedestrian and diverse coals that are combusted for no other purpose than to produce heat. With adequate processing, many steam coals can be used as coking coals, so that the coking coal market can be thought

of as one part of the world coal market in which premiums are paid for certain characteristics. Furthermore, as steel making technology evolves in a direction that reduces the demand for coking coals, many formerly metallurgical coals no longer undergo the extra processing and are sold as steam coals. Accordingly, it is most useful to think of the world coal market as a steam coal or energy market, in which coking coals are just one of the many forms of differentiation of the basic commodity.

Reference is often made to Pacific and Atlantic markets for coal, but these labels must be understood as only geographic terms without meaningful economic distinction. In fact, the best evidence of the unity of the world coal market, and of the existence of a world coal price, is the very similar movement of prices in these geographically distinct regions, as seen on Figure Two which shows the average CIF value for steam coal imported into Japan and the EEC. The coals being shipped to each of these importers are quite different, as are of course the buyers; and yet, despite the different origins, contracting and purchasing requirements, the average prices not only move together but are almost identical.

When netted back to the exporters, the price levels are different according to location and quality of coal, but the same degree of covariance would be observed. The explanation for the observed unity of pricing is not just South Africa, that can readily move coal supplies from one basin to the other, but the ready contestability of these geographic markets by exporters who for locational reasons are not locally dominant. For instance, most steam coal from the US is exported to Europe, but some still goes to importers in the Pacific in direct competition with Australia. Similarly, most Australian

steam coal is exported to Asia, but some still goes to Europe in direct competition with US coal. The result is a unified world coal market.

THE UNITED STATES AS THE RESIDUAL SUPPLIER

There is no commodity exchange that aggregates bids and offers to establish a common reference price for coal, such as exists for Brent crude, tin or wheat. Instead, there are quotes and representative prices, which can be readily found in the trade press, for purchases CIF Rotterdam or Yokohama, or FOB port in the US, South Africa, Australia or Canada. As shown in Figure Two, these prices move together as if there were a common reference price. The appropriate analogue for the world coal market is not the commodity exchange, but the world crude oil market as it functioned during the years 1973 through 1986, when the world oil price was established by a residual supplier, in that case, Saudi Arabia. The applicability of this analogue is suggested by the occasional reference in the industry and trade press to the United States as the "swing supplier" among the coal exporting nations.

The position of the United States as the residual supplier can be seen first in the more cyclical volume of US coal exports. Figure Three compares the export levels of the four principal coal exporters, the US, Australia, South Africa, and Canada, since 1970. The patterns among the four are very different. Although well established today, Australia, South Africa and Canada were new entrants to the seaborne coal trade in the early 1970s. Their exports have increased steadily over the intervening two decades, almost regardless of market condition, as would be expected of new entrants who are inframarginal producers. In contrast, US exports have fluctuated greatly, reflecting market

conditions, as might be expected of a residual supplier; but US exports remain in 1993 at approximately the same tonnage as in 1970.

The residual position of the United States can also be observed in the continual yielding of market share by the United States to new entrants who are willing and able to compete to gain market share. Those who were the new entrants in the 1970s are now the principal coal exporters, but a new set of market entrants has appeared in the 1980s. China, Indonesia and Colombia now export about 15 million tons a year each, while the newest entrant Venezuela has only recently begun to increase production and exports. All were minor to nonexistent coal exporters as recently as 1980. Whether the more recent new entrants will follow the same course as Australia, South Africa and Canada is yet to be seen, but there is demonstrably no difficulty in entering the world coal market. The continuing entry of new exporters into the world coal market has diminished the US share of total seaborne exports. As seen in Figure Four, the US share has fallen from just under half in 1970 to about 15% today. Today's US share is half that of Australia, and approximately equal to Canada and South Africa together or the total exports of the four newest entrants.

The importance of the residual supplier resides not so much in its share as in its capability to meet incremental demand, as was demonstrated in the years around 1980. US exports increased by 60 million tons from 1978 through 1981 when suddenly increased demand, due to the 1979-80 hike in crude oil prices, was joined with restricted supplies, caused by the Solidarity strikes in Poland. In the next two years, when the subsequent world wide recession took effect and Polish exports resumed, it was the US that absorbed the slack as US coal exports fell by 30 million tons.

Capability to meet incremental demand derives from a large and open domestic market. Figure Five shows the extraordinary disproportion between exported and domestically consumed production for the principal exporters. US coal exports are produced principally in only one of the country's three major producing regions, Appalachia; but even so that one region produces annually more than twice that of Australia, now the largest exporter in the world coal market. Only the United States possesses the current capability to produce for a domestic market large enough to accommodate easily increments of demand in the world coal market. In this respect, the position of the United States cannot be matched by any of the other principal exporters today, and eventually only by China or perhaps Russia.

The position of the United States as residual supplier to the world coal market suggests that the world price of coal would be determined in general by the price of coal in the United States, and more specifically , the price at which American coal is available at US ports, typically Hampton Roads, the largest port servicing Appalachia. In fact, the trend in these two prices is remarkably similar, as shown in Figures Six and Seven. Figure Six presents the bituminous coal component of the Producer Price Index for the United States since the late 1940s. Figure Seven presents the price of coking coal imported into Japan from various destinations since the mid-1960s. As can be readily seen, the real price of coal in the United States, and (since the 1970s) in the world coal market, has not followed a smooth trend. There have been three distinct periods since the end of the Second World War: falling prices for approximately twenty years until the late 1960s, sharply rising prices in the 1970s, and the resumption of declining prices in the 1980s and 1990s.

So long as the US is the residual supplier to the world coal market, the price of coal in its large domestic market will matter more than the domestic price of any other exporter. Accordingly, the price at which coal is available in US ports provides the marker against which buyers and sellers in the world coal market measure bids and offers. New entrants, or existing exporters, wishing to expand share, must match the delivered equivalent of this price; for buyers are not likely to pay more than the same for additional supplies. Likewise, those who would import coal from the United States must bid it away from the ample home market. Thus, the US price, and specifically that which prevails in the Appalachian region, forms the base for the world price of coal.

DETERMINANTS OF THE U.S. AND WORLD PRICE OF COAL

If the price of coal in the United States determines the world price of coal, the remaining question must be what determines the price of coal in the United States. Our concern here is not annual perturbations, but the longer term movements that are so evident in Figures Six and Seven.

The alternating trends in the price of coal roughly coincide with what were viewed as the dominant realities of the industry during each of the periods: loss of market share to oil and natural gas during the 1950s and 1960s, rising crude oil prices in the 1970s, and over-capacity in the 1980s. These conditions probably contributed to the observed changes in output price, but in each period, they fail to provide a satisfactory explanation. For instance, loss of market did occur during the 1950s; but coal production increased by about 45% during the 1960s due to rapid growth in the demand for electricity. Thus, although declining markets would tend to depress price, this cause cannot explain the persistent decline in the real price of coal that continued through the 1960s.

The sharp increase in coal prices during the 1970s is often attributed to higher oil prices, but there was no marked increase in the rate of growth in coal production. Higher crude oil prices undoubtedly sustained the demand for coal; but, the crude oil price shocks do not show up as surges of demand that would have pressed existing productive capacity to the limit and caused coal prices to rise.

The influence of crude oil prices on coal prices can be further questioned by juxtaposing the trend of petroleum product prices and coal prices over the same period, as is shown by Figure Eight. Both coal and oil prices increased in the 1970s, but that is where the similarity ends. There is no discernible reflection of the second OPEC oil price increase in 1979-80, nor of the oil price collapse in 1986. More pertinent, coal prices started increasing sharply in 1970 and had risen by about half the total increase by 1973, when the first oil price shock hit. Thus, crude oil price increases may have contributed to the sharp increase in coal prices during the 1970s, but the price of crude oil has not been the primary determinant of coal prices.

It is the conventional wisdom in the coal industry in the United States that the falling coal prices of the 1980s reflect over-capacity. Exuberant expectations very likely did cause investment to outrun demand during the early 1980s with the result that excess capacity was created and prices depressed. Nevertheless, this explanation offers at best a short-term explanation, and it is not sufficient to explain what is now almost a twenty year trend of declining prices. Furthermore, production has continued to increase, (by almost 50% since coal prices started to decline in the late 1970s), and new capacity has been regularly brought on line both to replace exhausted mines and to meet new demand.

Changing labor productivity, has been adduced as one of the causes of the increase in coal prices during the 1970s. Labor productivity did deteriorate markedly in the 1970s, and it improved steadily during the 1950s and 1960s, and from the 1980s on. The failure to relate improving labor productivity to coal price movements during periods other than the 1970s is notable, but understandable in that wage rates and capital requirements were rising at the same time. Absent measures for other factors of production, it was not clear what was the net balance of these considerations.

The data to address the broader question of multifactor productivity at the industry level has become available only recently due to the efforts of Dale Jorgenson and his colleagues. Jorgenson's data provides quality-adjusted measures of price and quantity for four factors – capital, labor, energy and materials – and the appropriate gross measures of output and price for the coal industry from the late 1940s through 1985.² From this data, a share-weighted index of multifactor productivity change can be created for the past 40 years, as well as the inverse, an index of unit input, which indicates the amount of each factor used in the production of one unit of output. As the inverse, declining unit input corresponds to increasing productivity which with unchanging factor prices implies falling prices; and, vice versa, for rising unit input.

The most striking aspect of the unit input index is the correspondence with the trend in output price as shown at Figure Nine. Unit input and output price decline at approximately equal rates through the 1950s and 1960s, as would be expected if factor prices remain unchanged. The 1970s are characterized by rising unit input and rising output price, although at different rates. By the end of what appears to be a decade of technical regress, sixty percent more aggregate input is required to produce a unit of

output, and that input costs some forty percent more in real terms. Then, technological progress seems to reappear and unit input and prices decline steadily again. The turning points and magnitudes of output price and productivity change are not exact; but the unit input index leaves little doubt that changing productivity is the major explanatory factor for the trend in coal prices in the United States since the end of the Second World War.

A complete accounting of the change in output price during the three post-war phases is presented in Table One. Improving productivity is the principal explanation for declining prices through the late 1960s and from the 1980s on. The 1970s stand out not only for the sharp reversal of productivity, but also rising real factor prices which account for about forty percent of the increase in output price.

The explanation for the periods of falling real price can be readily credited to the technological progress that appears as improving multifactor productivity, but periods of technical regress are unusual and call for some explanation. There does not appear to have been any cessation of engineering improvements during this period. For instance, productivity enhancing innovations, such as longwall mining systems and draglines, continued to be introduced. The appearance is that technological progress did not stop, but was overwhelmed by something else. A complete analysis of the causes of the declining productivity of the US coal mining industry in the 1970s cannot be presented here, but the likely causes can be identified.

First, the decline in productivity coincided with a period of intense legislative and regulatory activity aimed at internalizing non-market costs of coal mining. The two most notable instances are the Mine Health and Safety Act, enacted in 1969, and state and

federal surface mining laws. Both of these regulatory efforts imposed numerous requirements on coal mining that had the effect of requiring additional equipment, materials, labor and energy.

A second probable cause is the effect of the UMWA-BCOA labor agreements that terminated the major strikes of 1974 and 1977. The 1970s were years of almost ritualistic strikes by unionized labor at the time of contract renegotiation, as well as wildcat strikes between, all of which diminished labor productivity. These strikes occurred at times of great concern about energy supplies, provoking presidential intervention in 1978, and a general expectation, born of the 1973 oil price increase, that the demand for coal would increase dramatically. Under the circumstances, it is not hard to imagine that the contract settlements were motivated more by a desire to get the mines back into production than to resist union demands for requirements that would impair productivity. Furthermore, coal prices were already rising and there was little reason to think that higher costs could not be passed on.

Indirect support for the effect of the contract settlements can be found in the remarkable decline of the union share of production since then. In the early 1970s, about two-thirds of national production was produced in union mines. Twenty years later, when national production is some 75% greater, the union share of production is less than a third. The most obvious explanation is that union mines bear higher costs than non-union mines, and that the penalty has been what could be expected.

Given the structure of the world coal market, changing coal mining productivity in the United States has determined the world price of coal. When the cost of producing coal in the United States rose during the 1970s, the price of coal from all other exporters

rose similarly, as shown by Figure Seven. And when production costs and prices in the United States declined in the 1980s, the price received by competing exporters declined as well. It is quite easy to imagine that the technological improvements that seem to account for the declining prices for most of the post-war period were available elsewhere, so that costs and prices would move in tandem; however, it would be quite extraordinary if the cost increases experienced in the United States in the 1970s were similarly replicated among exporters as diverse in circumstance as Australia, Poland and South Africa. The more likely case is that the rising world price of coal, reflecting the circumstances of the residual supplier, created the profits and subsequent new supplies that have diminished the subsequent US share of the expanding world coal market.

Although the technical regress of the 1970s may have been restricted to the United States, there is nothing unique about the technological changes that have caused prices to fall since the late 1970s. Technological improvements are notoriously hard to restrict to national borders; and there is very little reason to think that the improvements in productivity that can be observed in the United States did not occur elsewhere. Accordingly, the third proposition may provide a more robust explanation for the world price of coal, one that is not restricted to the residual supplier model, but would apply equally if countries with domestic markets and reserve positions comparable to the US, namely, China and Russia, become more than incidental participants in the world coal market.

IMPLICATIONS FOR EUROPE

The effect of the three propositions that have been advanced in this paper is that Europe can obtain coal from a large international market where supplies are quite adequate and prices have been steadily declining. For any point in Europe, coal is available at the world price plus freight. As a result, that price will become increasingly the standard for determining Europe's coal production and consumption.

The ready availability of coal at competitive prices on the world coal market does not necessarily mean that all European production will be displaced by imports, as is being demonstrated in the United Kingdom. Three circumstances work towards the continuation of some domestic mines. First, not all domestic mines are high cost, uneconomic mines. Second, even for mines which appear uneconomic, the combination of factors in use in protected industries is rarely the most efficient. The same policy framework that allows protectionism permits the pursuit of other social goals, such as employment, that are not always compatible with competitive prices. With the abandonment of these policies, and often the adoption of more recent technology, unit costs can be brought down to the level of import prices.

The third circumstance promoting the continuation of some domestic production is a subtle legacy of past protection. Transportation costs cause industries dependent on coal to locate close to the mines, but those industries cannot easily relocate if imports become the cheaper source of coal. Where the domestic mines are inland, the sunk costs of past industrial location create an advantage for those mines, equal to transportation cost from the coast. When combined with decent geological conditions,

more efficient use of factors, and technological innovation, more of the protected industry may survive than would at first seem likely.

Finally, and despite the disclaimer at the beginning, a comment may be permitted on the likely future trend in the world coal price. When seeking to determine future prices, it is customary to develop supply curves that represent the costs, based on today's reserves and technology, at which successive increments of production can be brought to market. Invariably, these supply curves are very flat, but they do rise as increasingly greater demands are placed upon existing reserves. When future, and typically increasing, demand is projected against these static supply curves, rising prices are indicated at the time when the future demand is expected to materialize. What is not being captured in these exercises is what will be learned between today, when the supply curves are estimated, and tomorrow, when the increased demands will be realized. For most of our past experience, the process of learning and continual improvement that we call technological progress has shifted the gently rising supply curves downward so that the actual path of realized prices when traced through time has been falling.

Forces that would counter the effect of continuing technological progress in coal are hard to identify. Depletion of coal reserves on a global scale is too distant a possibility to have any effect, and long-term coal supply is sufficiently elastic that rising oil and natural gas prices will have more effect on the quantity demanded than on the price of coal. Over-capacity may imply a higher price when the excess is wrung out, but no long term trend is implied. The argument must be recognized for what it is -- a reflection of disappointed price expectations -- rather than an accurate description of

what has been occurring in the world coal market for the past fifteen years. Any notion of rising prices due to cartel-like behavior by producers can be set aside given the dispersion of world coal reserves, the demonstrated ease of entry, and the super competitive behavior of existing coal producers.

Future coal prices will depend on the trend in the costs of production, very much as they have in the past. So long as the United States is the residual supplier to the world coal market, productivity trends in the US coal industry will be the more important than elsewhere, but this is not to say that there is anything unique about productivity change in the American coal industry, nor that the structure of the world coal market will not change over time. China and Russia are coal producing giants with comparable reserves who to date have been only incidental participants in the world coal market. Given the events since the fall of the Berlin Wall, we can envisage a time when there would be no clearly identifiable residual supplier, but it is hard to imagine that the competitive nature of the world coal market would be any different, or prices based on anything other than the costs of production as determined by future technological change among all coal producers and exporters.

It may seem very speculative to forecast what we will learn tomorrow, or equivalently, the rate at which our current ignorance will be reduced; but not to do so is to adopt an assumption of technological stagnation that defies the historical record, not only for coal but for other industries, and economic activity in general. In this circumstance, the extrapolation of past experience is not without merit. A bias towards declining prices merely reflects confidence in mankind's continuing ability to wring more from nature.

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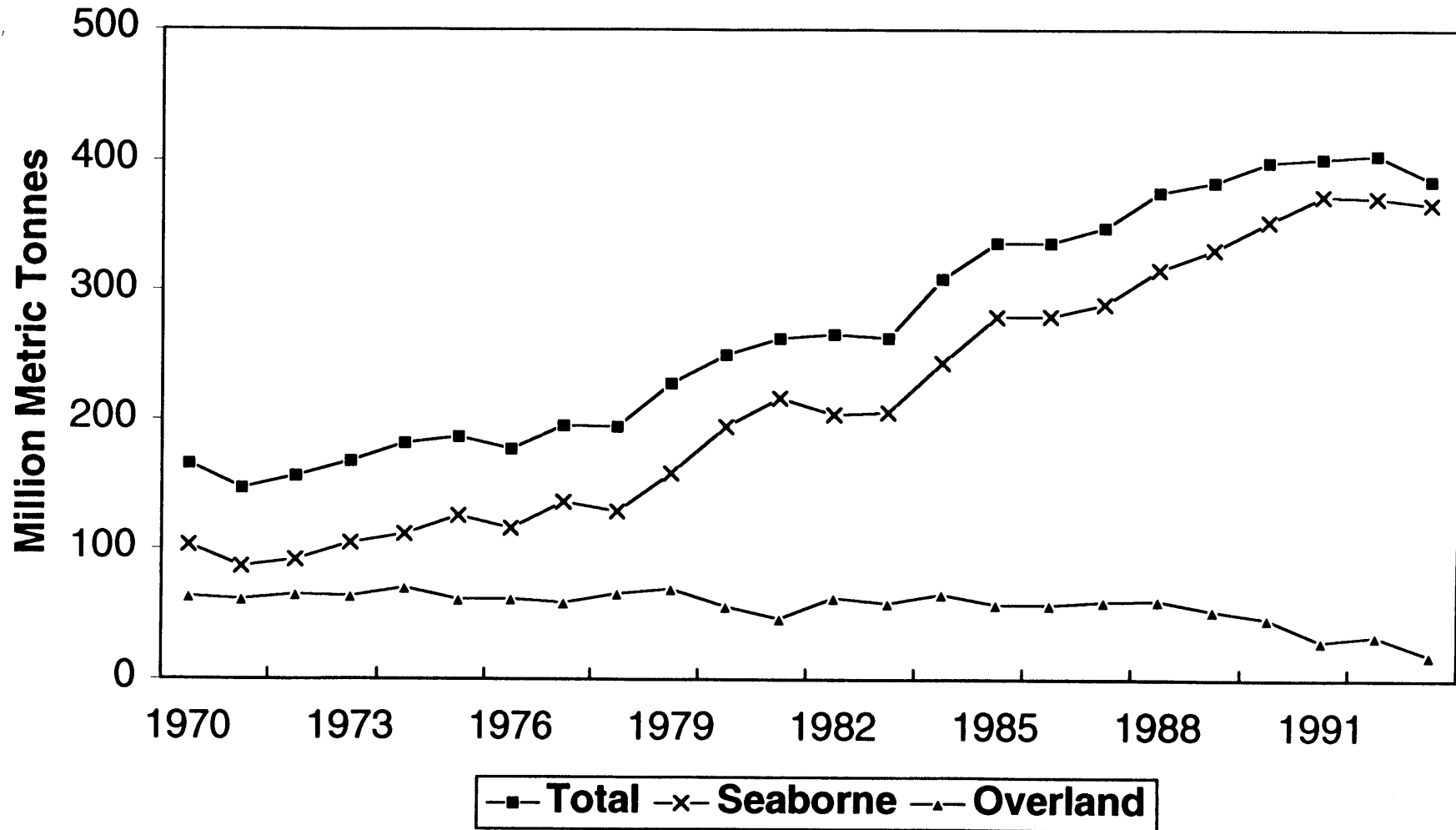
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ENDNOTES

¹ Senior Lecturer, Sloan School of Management, and Executive Director, Center for Energy and Environmental Policy Research

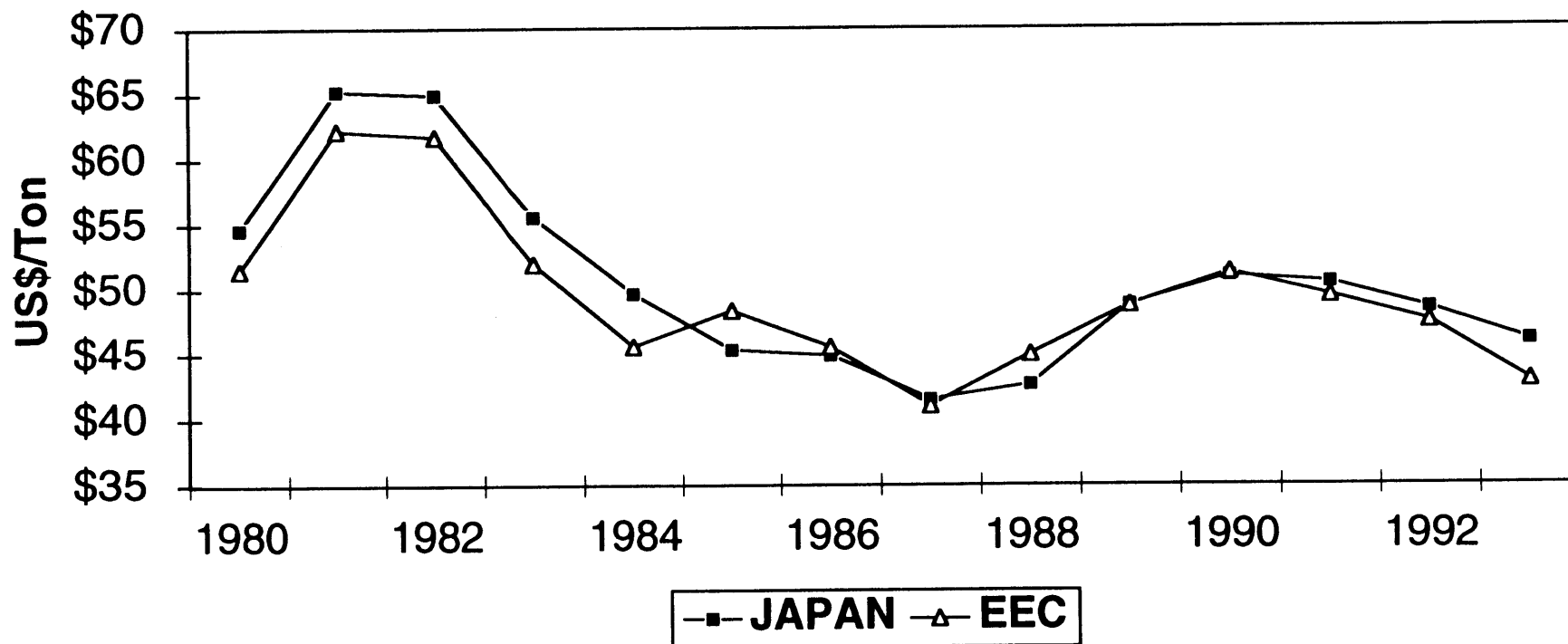
² See Dale W. Jorgenson, Frank M. Gollop, and Barbara M. Fraumeni, *Productivity and U.S. Economic Growth* (Harvard University Press, 1987) for the most complete explanation of the derivation of the data, as well as the actual data through 1979. The data used in this paper are updated through 1985 provided by Jorgenson and Fraumeni. The slight changes in the data series through 1985 are discussed in Dale W. Jorgenson, "Productivity and Economic Growth," in Ernst R. Berndt and Jack E. Triplett (eds.), *Fifty Years of Economic Measurement: The Jubilee of the Conference on Research in Income and Wealth* (University of Chicago Press, 1990).

Fig 1: WORLD COAL TRADE By Method of Shipment



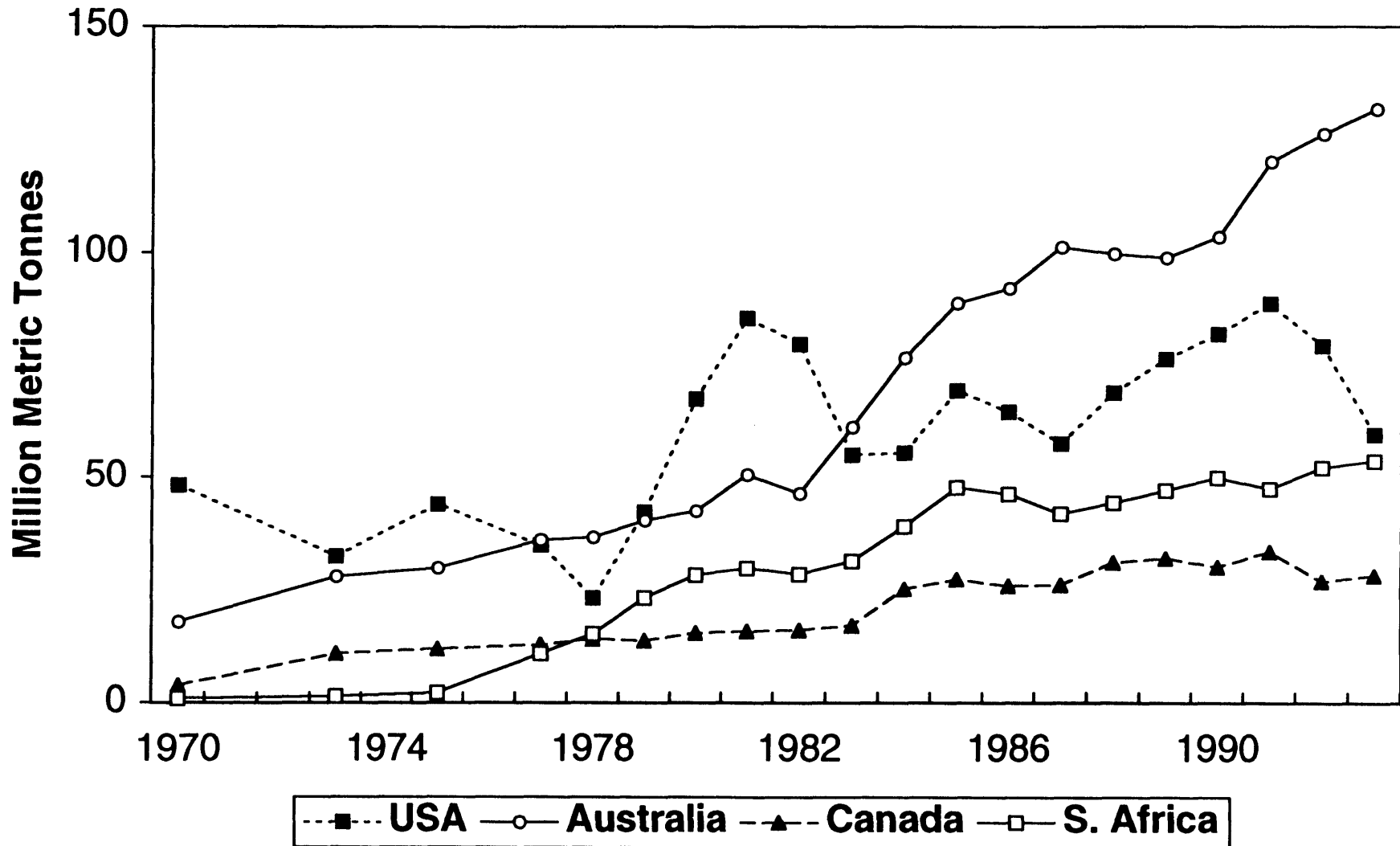
Sources: 1978-93, Coal Information 1993
 1970-77, based on Coal Trade Statistics and 1981 Coking Coal Manual

Fig 2: STEAM COAL IMPORT VALUES
Average CIF Value



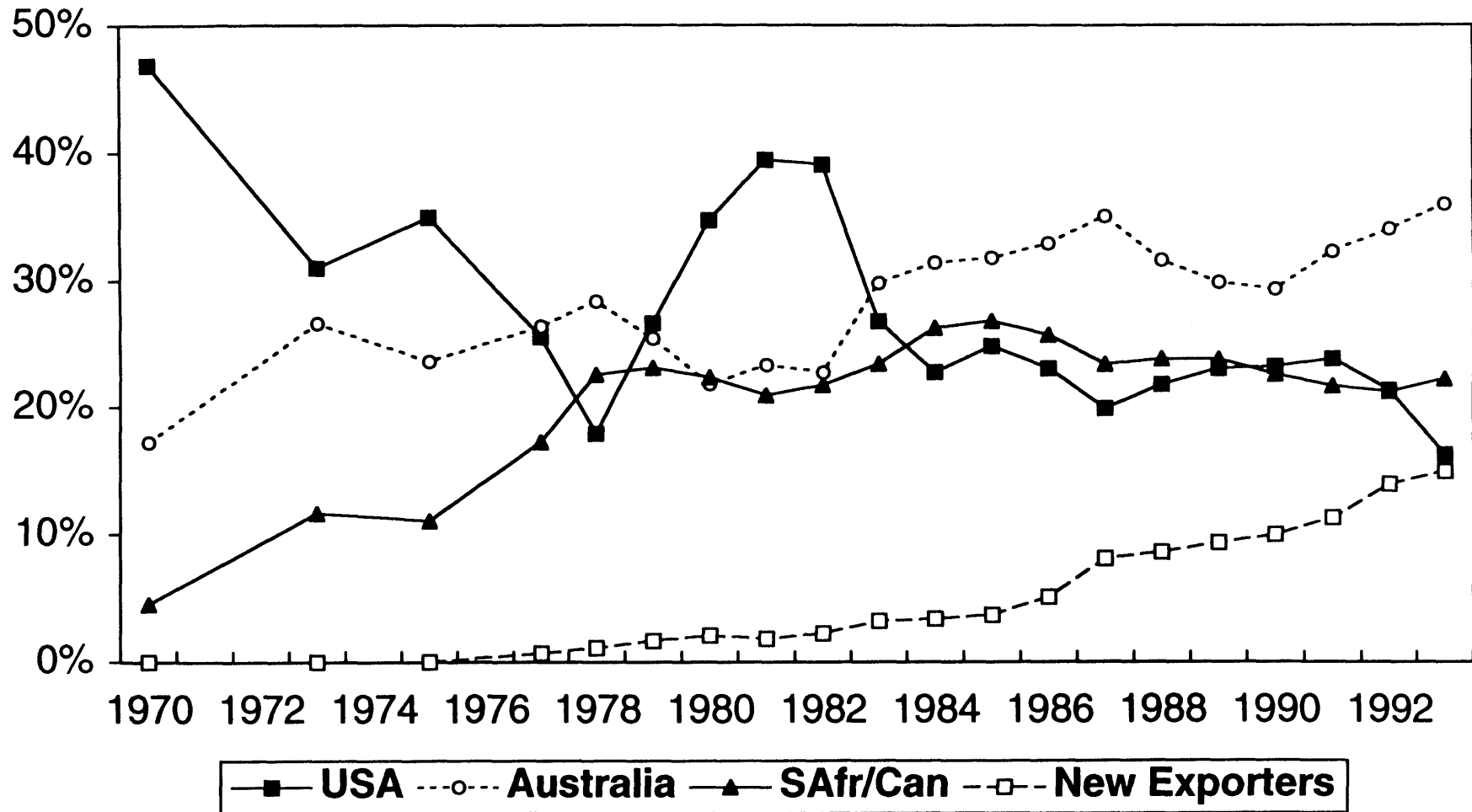
Source: Coal Information 1993

Fig 3: PRINCIPAL COAL EXPORTERS
Seaborne Trade Only



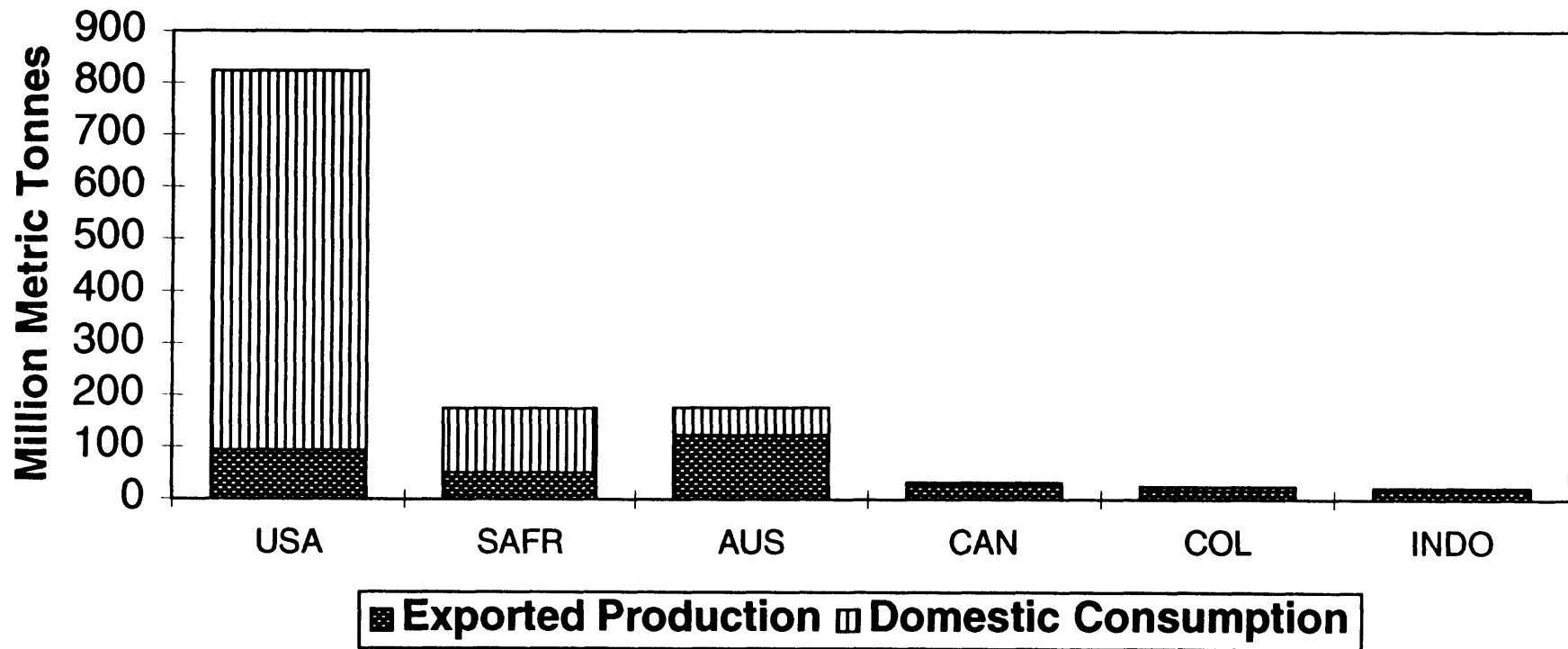
Source: Coal Information 1993, Coal Trade Statistics, 1973-79.

**Fig 4: COAL TRADE SHARES
Seaborne Trade Only**



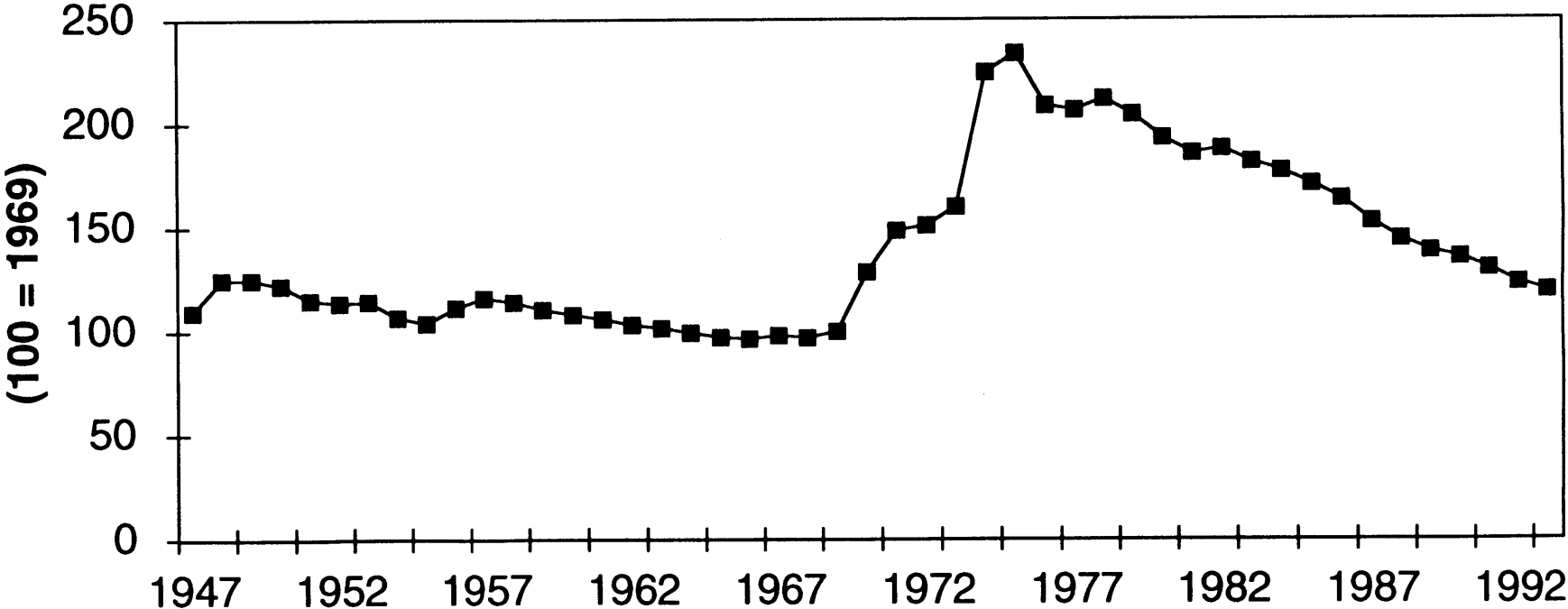
Source: Coal Information 1993; Coal Trade Statistics.

**Fig 5: EXPORT DEPENDENCE
Selected Coal Exporters, 1992**



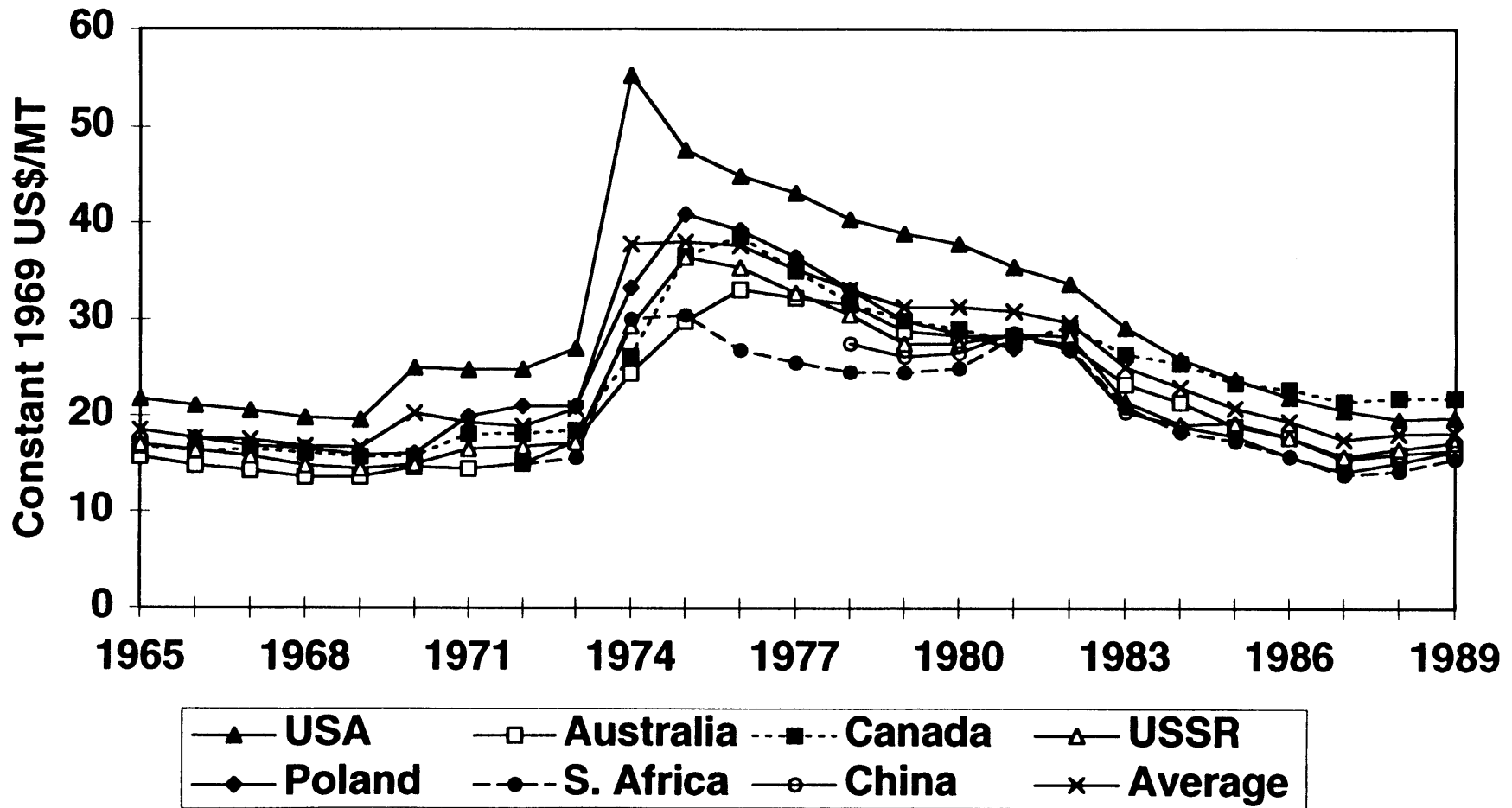
Source: Coal Information 1993

**Fig 6: US COAL PRICE
Constant Dollars**



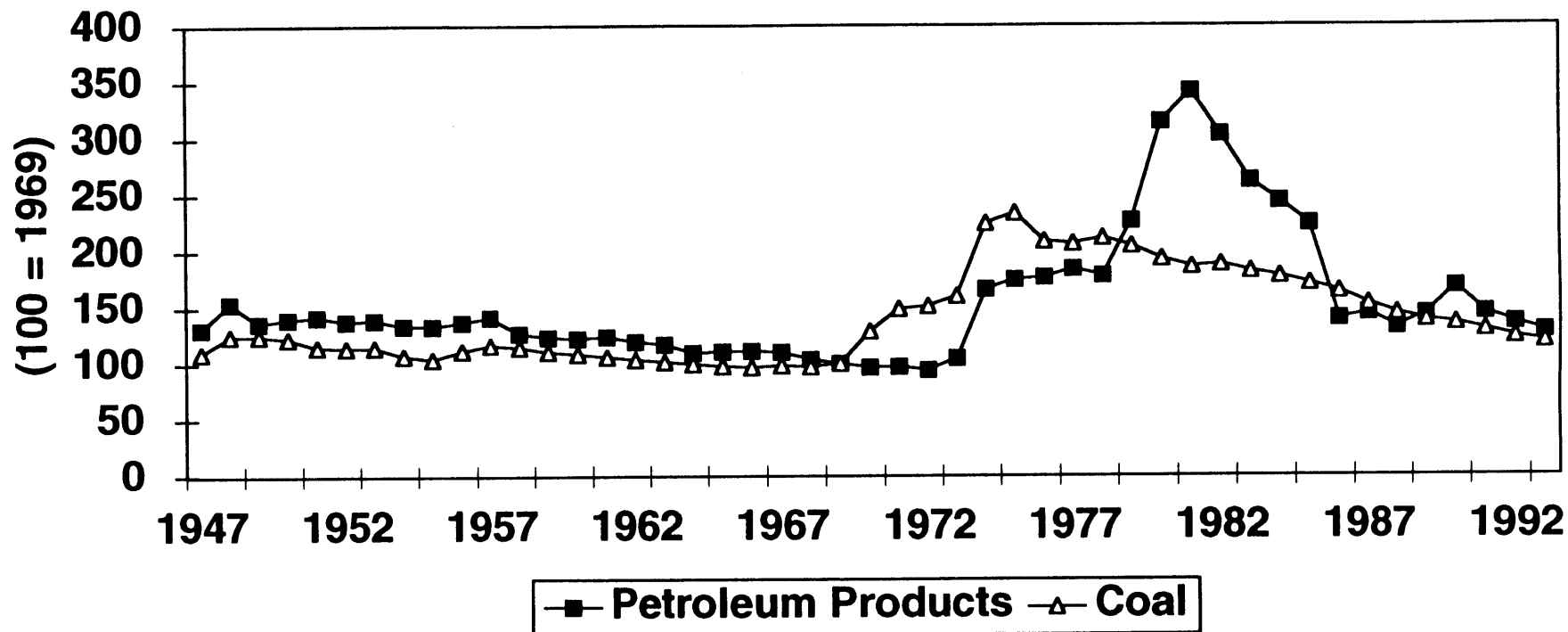
Source: Handbook of Labor Statistics, Monthly Labor Review
Note: Nominal index deflated by GDP deflator.

Fig 7: CONSTANT DOLLAR COKING COAL PRICES TO JAPAN



Source: 1981 Coking Coal Manual, p. 25; 1991 Coal Manual, p. 35; Economic Report of the President, 1994, Table B-3, p. 272.

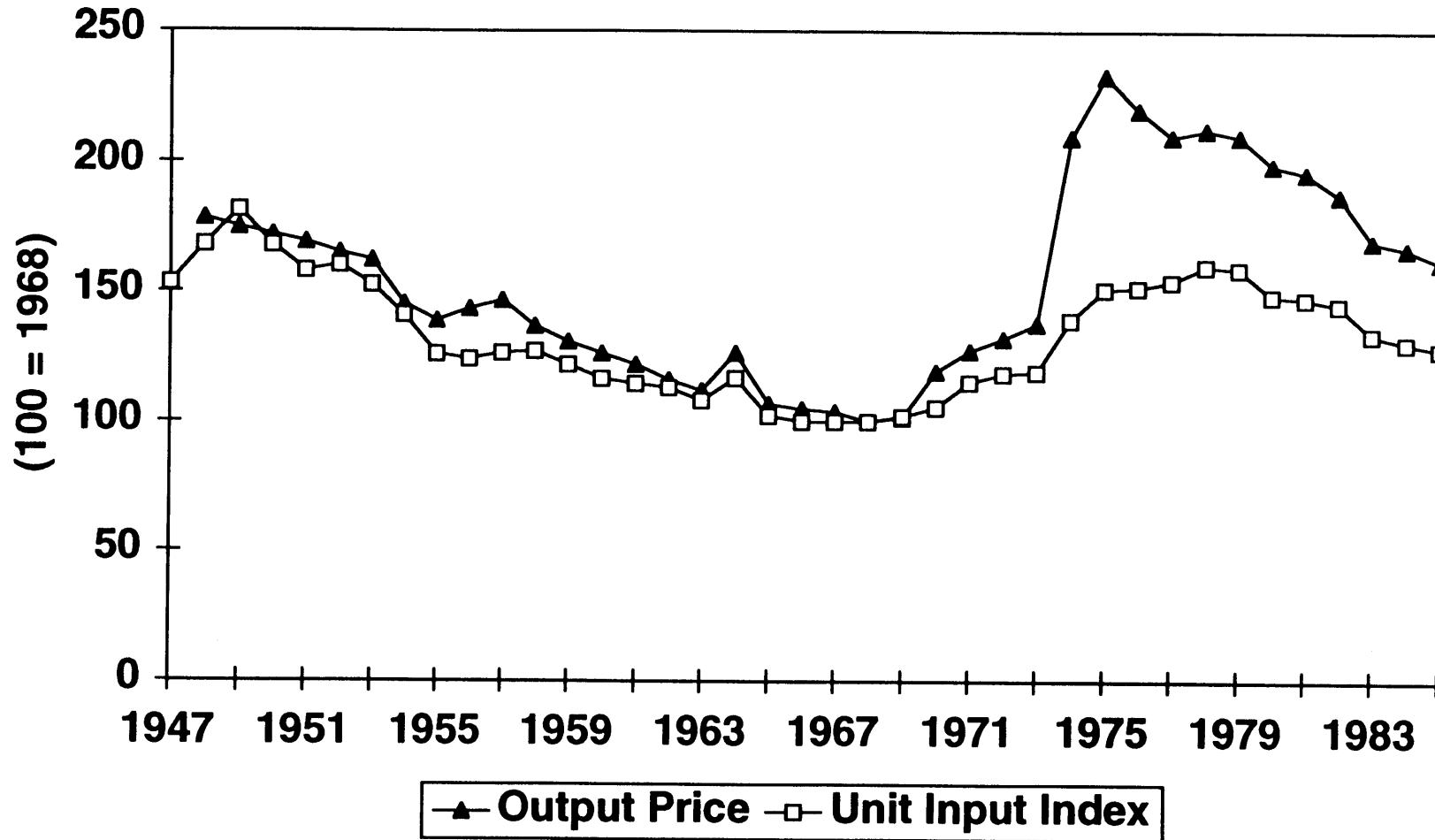
Fig 8: U.S. COAL AND OIL PRICES Constant Dollars



Source: Handbook of Labor Statistics, Monthly Labor Review

Note: Nominal index deflated by GDP deflator.

Fig 9: U.S. COAL PRICE AND PRODUCTIVITY



Source: Derived from data provided by Dale Jorgenson and Barbara Fraumeni.
Note: Nominal output price deflated by GDP deflator.

TABLE 1: DECOMPOSITION OF OUTPUT PRICE CHANGE

U.S. Coal Industry, 1947-1989

	Indices				Annual Rates of Change		
	1947	1969	1979	1989	1947-69	1969-79	1979-89
REAL OUTPUT PRICE	100	68	172	96	-1.75%	9.30%	-5.82%
FACTOR PRICE INDEX	100	95	140	125	-0.24%	3.87%	-1.07%
LABOR	100	136	207	218	1.39%	4.23%	0.50%
CAPITAL	100	36	58	54	-4.66%	4.88%	-0.86%
ENERGY	100	68	156	98	-1.73%	8.26%	-4.62%
MATERIALS	100	102	99	90	0.07%	-0.24%	-0.94%
UNIT INPUT INDEX	100	72	124	77	-1.51%	5.43%	-4.75%
LABOR	100	47	64	29	-3.46%	3.14%	-7.87%
CAPITAL	100	149	269	229	1.82%	5.88%	-1.60%
ENERGY	100	77	122	91	-1.18%	4.58%	-2.94%
MATERIALS	100	117	297	199	0.70%	9.36%	-4.00%
FACTOR SHARES							
LABOR	48.5%	45.1%	37.2%	31.8%			
CAPITAL	17.3%	13.7%	15.8%	22.1%			
ENERGY	18.9%	14.6%	20.8%	17.5%			
MATERIALS	15.3%	26.6%	26.1%	28.5%			

Source: Derived from data provided by Dale Jorgenson and Barbara Fraumeni