Mineral Taxation in Jamaica:

An Oligopoly Confronts Taxes on Resource Rents —and Prevails

By M. H. I. Dore*

ABSTRACT. The reallocative effects on *bauxite* production in *Jamaica* following the imposition of an *ad valorem tax* in 1974 are considered. The international *aluminum* industry, being both vertically and horizontally integrated, evolved a successful strategy of time-phasing *bauxite* production capacity worldwide. The non-neutral tax not only made Jamaican bauxite uncompetitive with the output of other producers but also eroded the cost differential between bauxite and alternative sources of aluminum ore. The study claims that the consequences of the tax have been disastrous, and it argues that the ad valorem tax on the recovered ore must be replaced by some form of a *profits-based tax*.

I

Introduction

The theoretical case for taxing resource rents from non-renewable resources is based on an important proviso that such taxation should not in any way lead to a loss of allocative efficiency. In practical terms the condition means that such taxes should be so devised as to minimize tax-induced changes in resource utilization, for all taxes—except the lump sum tax—distort both effort and economic activity. A resource rent tax that is non-distortionary is often called a Pigouvian or a neutral tax. Such a neutral resource rent tax will have at least four desirable properties: it would enable the government to tax away a higher share of rents than before; it would not impair incentives to exploit existing deposits and to locate new ones; it should not require a higher administrative cost; and lastly it should not be possible to evade the tax.

The importance of a simple and well-designed fiscal regime as a whole is especially necessary for developing countries. In such countries government revenues are often volatile due to an excessive reliance on one or two export

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Table 1

Aluminium Price Ranges and Annual Averages

Annual high, low and averages of primary aluminium 99% or higher. Delivered buyer's plant. Quoted by AMERICAN METAL MARKET in cents per pound.

	Low High	Aver.		Low High	Aver.		Low High	Aver.
1924	26.00-28.00	27.03	1950	16.00-18.00	16.69	1967	24.50-25.00	24.98
1925	27.00-28.00	27.19	1951	18.00-18.00	18.00	1968	25.00-26.00	25.57
1926	26.50-27.00	26.99	1952	18.00-19.00	18.40	1969	26.55-28.00	27.18
1927	23.90-27.00	25.41	1953	19.00-20.00	19.70	1970	28.00-29.00	28.72
1928-9	23.90-23.90	23.90	1954	20.00-20.50	20.20	1971	29.00-29.00	29.00
1930	23.30-24.30	23.79	1955	20.50-22.50	21.88	1972	25.00-29.00	26.45
1931-3	23.30-23.30	23.30	1956	22.50-25.00	24.03	1974	29.00-39.00	34.06
1934	19.00-23.30	21.58	1958	24.00-26.00	24.79	1975	39.00-41.00	39.79
1937	20.00-20.50	20.08	1959	24.70-26.00	24.75	1976	41.00-48.00	44.49
1938-9	20.00-20.00	20.00	1960	26.00-28.10	27.23	1977	48.00-53.00	51.33
1940	17.00-20.00	18.69	1961	24.00-26.00	25.46	1979	55.00-65.00	59.39
1941	15.00-17.00	16.50	1963	22.50-23.00	22.62	1980	66.00-76.00	69.57
1948	14.00-16.00	14.74	1964	23.00-24.50	23.72	1981	76.00-76.00	76.00
1949	16.00-16.00	16.00	1965-6	24.50-24.50	24.72	1982	76.00-76.00	76.00
						1983	76.00-81.00	77.67

Sources: American Metal Market, Metal Statistics 1980;
American Bureau of Metal Statistics, Non-Ferrous Metal Data 1983, Secaucus, N.Y.:
American Bureau of Metal Statistics, 1984

commodities. Those commodities are typically mined exclusively by or in co-operation with multinational enterprises, whose operations are global in character. Within such a context, governments of developing countries face additional problems in the design and implementation of a tax system. These additional problems arise from the nature of the industry concerned as well as the resource endowments of the developing country. This paper considers one developing country's attempt to raise government revenue by capturing resource rents.

This is the experience of Jamaica, a leading member of the International Bauxite Association (IBA). Section II is an outline of the oligopolistic nature of the international aluminum industry which was a crucial factor in the industry's ability to respond to the imposition of a high tax in Jamaica in 1974. The response, which took the form of reallocation of bauxite production away from Jamaica, is discussed in Section III. Finally, in Section IV, the details of the Jamaican *ad valorem* tax are considered. It is shown that this non-neutral tax raised the price of Jamaican bauxite above the IBA guideline and was out of line with taxes in other bauxite producing areas. It also significantly narrowed the cost differential between alumina from bauxite and alumina from non-bauxite sources, the supply of which is plentiful. The paper concludes by considering the eight years of negative growth that has reduced Jamaican per capita income to where it was 20 years ago, and argues that the crisis in the bauxite industry, now operating 40% below capacity, needs to be resolved quickly.

II

Oligopoly and Monopsony in Aluminum

THE INTERNATIONAL ALUMINUM INDUSTRY has a long history of oligopolistic behavior. The first cartel agreement between the major aluminum companies dates as far back as 1896. Six other cartel agreements were made between 1896 and 1926 to apportion market shares and thus reduce price competition.[1] Before the Second World War, another cartel agreement preceded the incorporation of the *Alliance Aluminium Compagnie* in Switzerland, and each member's proportion of shares in the Alliance determined its quota of total production. *Alcoa* participated in this agreement through its Canadian subsidiary, Northern Aluminium Ltd., which later became known as Aluminium Ltd.[2]

Because of strong opprobrium attached to explicit agreements which are clearly in restraint of trade, the postwar period was characterized by tacit cartel-like agreements in the international aluminum industry. In fact the *Metal Bulletin* has called it a "gentlemen's agreement."[3] While most Western companies have observed the spirit of the agreement, new producers of Eastern Europe and the developing countries with State controlled companies could potentially destabilize the aluminum market. It was therefore considered essential that this increase in supply be absorbed by the western companies. To this end each aluminum company signed a letter of agreement with Brandeis Goldsmidt (a large British commodity broker) in which the latter is authorized to acquire aluminium on behalf of the companies. The letter of agreement specifies, *inter alia,* the prices and quantities, and even the sources of metal. The object of this activity is clear: to reduce increases in supply due to the new producers, in order that aluminum prices may not weaken.

In 1971 a further step was taken to maintain administered prices. In Western

Table 2

The Stability of Aluminium Prices

	1. Standard deviation	2. Mean	3. (Col 1 ÷ Col 2) Coefficient of Variation*
1920-29	1.43	26.10	.0547
1930-39	1.76	21.75	.0811
1940-49	1.65	16.48	.0999
1950-59	3.06	20.94	.1462
1960-69	1.57	25.18	.0625
1970-79	12.27	39.36	.3117
1980-83	8.24	74.81	.1101

* The coefficient of variation is the ratio of the standard deviation to the mean of a series. It means, for example, that in the 1920s, any single year's price will be within plus or minus 5½% of the mean price about two thirds of the time.

Source: Table 1

Europe, a classic buffer stock type of company called *Alufinance and Trade Ltd.* was established in order to accumulate surplus aluminum stocks on behalf of all the participating companies.[4] Furthermore three overlapping trade associations have been formed: the European Aluminium Association, to which all West European producers belong, and the Aluminium Association to which all major producers of aluminium including North American as well as West European producers belong. All in turn belong to the International Primary Aluminium Institute which has some fifty members (in 1976) representing almost all of the Western World's smelting capacity. While there is no direct evidence of collusion and price-fixing through these trade associations, there is no doubt they present a potential for such an activity through informal contacts.

Indeed these arrangements have not only worked well but have given aluminum prices a remarkable stability for more than half a century, from 1924 to the present. This is in stark contrast to other primary metals such as copper

Table 3

The Real Price of Copper and Aluminium

	US Producer Price Index[1]	Copper Price (US¢ per lb)[2]	Real Price of Copper[3]	Real Price of Aluminium[4]
1963	100.0	30.60	30.60	22.62
1964	101.9	31.96	31.36	23.28
1965	104.1	35.02	33.64	23.54
1966	106.0	36.17	34.12	23.11
1967	107.5	38.23	35.56	23.23
1968	111.1	41.85	37.67	23.02
1969	117.5	47.53	40.45	23.13
1970	123.8	57.70	46.61	23.20
1971	127.7	51.43	40.27	22.71
1972	133.1	50.62	38.03	19.87
1973	143.8	58.85	40.92	17.39
1974	184.6	76.65	41.52	18.45
1975	202.1	63.54	31.44	19.69
1976	217.2	68.82	31.69	20.48
1977	235.5	65.81	27.94	21.80
1978	254.8	65.51	25.71	20.83
1979	291.7	92.33	31.65	20.36
1980	323.6	101.42	31.34	21.50
1981	335.6	83.74	24.95	22.65
1982	333.5	72.91	21.86	22.79
1983	343.3	77.86	22.68	22.62

Notes (1) U.S. producer price index of intermediate materials for durable manufacturing, 1963 = 100.
(2) U.S. producer copper refinery prices, yearly average in U.S. cents per lb.
(3) Column 2 deflated by column 1, 1963 constant prices
(4) Average price of aluminium in Table 1 deflated by column 1, 1963 constant prices.

Sources of data: Column 1 - U.S. Bureau of Labor Statistics
Column 2, 4 - American Bureau of Metal Statistics (1984).

which is plagued by extreme price volatility. The stability of aluminum prices is shown by the narrow range of low and high prices in each year since 1924 summarized in Table 1. Table 2, which gives the coefficient of variation of the last six decades, presents further evidence of price stability. The increase in the coefficient of variation in 1970-79 is mainly due to the turbulence in all commodity markets after the oil price explosions in the 1970s. In the recession that followed, aluminum prices continued to rise, whereas copper prices, for instance, fell substantially. In the first three years of the 1980s, the coefficient of variation has fallen to 0.11.

The conclusion reached above is strengthened further if the *real* price of copper and aluminum are compared (Table 2). If the annual average rate of change is computed for the 20 year period 1963 to 1983, it will be seen that the real price of copper fell by 1.5% per annum. This can be interpreted as an

Table 4

Capacity and Bauxite Sources of
The Four Companies in Jamaica

	Primary Aluminium capacity '000 short tons	Bauxite Requirements millions of short tons	Sources of Bauxite through local subsidiaries and/or joint ventures
Alcan	1,637	6.6	Jamaica, Brazil, Guinea, Australia, India, France, Ireland, Guyana, Surinam, Sierra Leone
Alcoa	1,962	7.7	Jamaica, Surinam, Dominican Republic, Brazil, Guinea, U.S., Australia
Kaiser	1,175	4.4	Jamaica, Australia
Reynolds	1,340	5.5	Jamaica, Haiti, U.S., Brazil, France, Australia
Alpart*			Jamaica

* wholly-owned subsidiary of Kaiser, Reynolds, and Atlantic Richfield

Source: S. Moment (1978)

approximate measure of efficiency gains in the copper industry. It is roughly comparable to the efficiency gains in the steel industry which averaged 2% per annum, *i.e.* the real price of steel fell at this rate (see Dore (1977) and World Bank (1974)).

Considering now the real price of aluminum, it will be seen from Table 3 that it is remarkably constant. This suggests that either there were no efficiency gains in the aluminum industry or that the gains were not passed on to the buyers of aluminum in the form of lower real prices, *i.e.* the gains were appropriated by the companies as higher profits.[5] Lastly, consider the percentage differential from the peak to trough for both metals' real prices. In the case of copper the differential is more than 80%; for aluminum it is only 35%. This again is a measure of the stability of aluminum prices relative to copper.

It should be obvious that such an enormous market (estimated to value US$1.5 billion in 1979) cannot be effectively controlled unless the number of producing companies is small. Indeed, the six largest producing firms (*Alcan, Alcoa, Kaiser,*

Table 5

Jamaican Bauxite and Alumina Capacity
in Millions of Metric Tons

	Bauxite	Alumina
Alcan	2.5	1.1
Alcoa	1.6	0.58
Alpart*	2.5	1.2
Kaiser	4.2	
Reynolds	3.7**	
TOTAL	14.5	2.85

* Wholly owned subsidiary of Kaiser, Reynolds and Atlantic Richfield.

** This capacity is disputed by the company, which maintains that its capacity is only 2.8m tons; the above figure is due to the Jamaica Bauxite Institute (JBI).

Source: Metal Bulletin Monthly, (London), April 1981

Reynolds, Pechiney and *Alusuisse*) dominate the industry from the stage of bauxite mining, to the production of alumina, to the production of aluminum ingots from alumina. In 1976, the six accounted for 8.0 million short tons of primary aluminum capacity, which is 57% of the total capacity of the Western countries. In 1977, at full capacity, the bauxite requirements of the six were estimated at about 32 million short tons. This amounts to around 35% of world bauxite output, or about 40% of the output of western countries. However, without the growth of bauxite output and smelting capacity in Africa, Asia and New Zealand in the late 1970s, the share of the six companies in the capacity of western countries would have been even higher. (See Appendix Table A1 for the distribution of world aluminum production).

Table 4 shows that four of the six companies that operate in Jamaica have large sources of bauxite in a number of other countries, *viz.* Australia, Guinea, Brazil, the Dominican Republic, Haiti and Sierra Leone.[6] Furthermore some of these companies have also participated with the others with a minority shareholding. For example, *Alcan* has operated in partnership with *Pechiney* and *Kaiser; Pechiney* has operated with *Alcan, Kaiser* and *Alusuisse; Kaiser* has operated with *Reynolds.* Thus the alternative sources of supply as well as the interpenetration among companies enabled the companies to organize and rationalize production on a world scale. To take just two examples, product swaps between companies operating in different markets could save on transportation costs; the costs of improvement in production technology can be shared by more than one company. This institutional feature turns out to be of considerable importance in the reallocation of production activity in the face of developments in Jamaica, which are considered in Section III below.

Table 6

Bauxite-Aluminium Industry Energy Requirements

Stage	GJ* per metric ton Aluminium	% of Energy
Bauxite Mining and Shipping	4.92	2.2
Alumina Refining	44.95	19.8
Aluminium Smelting	177.25	78.0
TOTAL	227.25	100.0

* 1 GJ = 0.9478 BTUs

Source: Sitting, M. (1978)

Finally the main characteristics of world supply of and demand for aluminum are summarized in Appendix Tables A1 and A2. World consumption of aluminum has grown at an annual average rate of 7.8% over the decade 1967–77. The oil induced recession meant that world aluminum demand fell by about 19% in 1975 over the previous year.[7] After the second oil price shock of 1979, it seems clear that there has been a downward shift in demand for all metals.

It was the oligopolistic structure of the oil industry that in part provided the stimulus for the formation of the producer cartel, (OPEC)—the Organization of Petroleum Exporting Countries. They were facing seven major oil companies. The situation in bauxite was somewhat similar. The producer countries that were in the greatest need for revenues were the developing countries, who felt that through transfer pricing the resource rents were being captured by the major vertically integrated transnational corporations (see Arthur (1980), and Graham (1982)). The success of OPEC no doubt had some influence, and in 1974, the International Bauxite Association (IBA) was formed with Jamaica playing a leading role in its formation. Its members were Australia, the Dominican Republic, Ghana, Guinea, Haiti, Indonesia, Jamaica, Sierra Leone, Surinam and Yugoslavia.

In part the IBA emerged after a series of conflicts between the governments of Guyana, Ghana, Surinam and Jamaica and the transnational aluminum oligopoly (Graham (1982)). When the IBA was formed there was some interest as to whether it would emulate OPEC in challenging the aluminum companies (Gilles and McLure (1975), Pindyk (1977, 1978, 1979)). Pindyk (1977) thought that the IBA had the potential to act like OPEC, but that much depended on how Australia acted. Its distance from the main markets of North America and Europe put Australia at a competitive disadvantage. On the other hand, it had some incentive to seek to capture a larger market away from the Caribbean members of the IBA. The high taxes imposed by the latter in 1974 were not matched by Australia. In fact it even ignored the IBA guideline to establish a minimum price of bauxite in 1979 at 2% of the average list price of aluminum ingot during 1979 (Litvak and Maula (1980)). Guinea too followed an independent policy, though its government took a 49% equity position in joint ventures with *Alcan, Alcoa, Pechiney* and others.

More than 10 years after its formation, it is clear that the IBA does not and cannot function as a producer cartel (*Financial Times* of London, November 9, 1983). Why this is so seems obvious. Although the IBA faced the same small number of companies, the latter evolved a very successful strategy of exploration and time-phasing of capacity world-wide, so that the experience of OPEC could not be repeated. Perhaps they even assimilated the lessons that the oil companies learned. Thus when Jamaica, the leading IBA member, imposed a heavy tax, the aluminium companies reallocated production. How this reallocation affected

Jamaica is examined in the next section. The final section will deal with the nature and consequences of this tax.

III

Reallocation of Production from Jamaica

THE MINING OF BAUXITE and the refining of alumina is carried out by four of the six major corporations referred to in Section II. Their total Jamaican capacity of both bauxite and alumina is given in Table 5. The first to arrive on the island was *Alcan,* which was formerly called *Aluminium Ltd.* and which began as a subsidiary of *Alcoa. Alcan* now manages a joint venture between itself and the Jamaican government. The latter owns 7% of the joint venture, called JAMALCAN. The joint venture with *Alcoa,* called JAMALCO is similar, with the government owning 6% of the venture, and *Alcoa* holding the rest. *Alcoa,* in its own right, was the last of the multinational corporations to arrive in Jamaica, although its former subsidiary was the first. It has two alumina refineries in Jamaica, one with a capacity of 0.5 million tons and another with a capacity of 80,000 tons. Almost all the alumina is sent to *Alcoa's* Massine smelter in New York State.

Reynolds now operates under an agreement whereby 51% of the mining assets, 100% of the farming assets, and 100% of the bauxite lands are now owned by the Jamaican government.[8] All of *Reynold's* Jamaican ore is refined into aluminum at the company's refinery in Corpus Christi, Texas. It uses about 2 million tons of Jamaican bauxite.

Kaiser Jamaica is the largest miner on the island; it accounts for 4 million tons per year which is about a third of the bauxite mined each year in Jamaica. The venture is 50% owned by *Kaiser.* Its half share of bauxite output is sent to its refineries in Baton Rouge and Gramercy in Louisiana.

ALPART (or Alumina Partners of Jamaica) is owned by *Kaiser* (37%), *Reynolds* (37%) and *Atlantic Richfield* (26%). Under strong government pressure, *Alpart* built a 1.2 million tons per year alumina refinery, which refines *Alpart's* entire bauxite output (maximum capacity 2.5 million tons per year) into alumina. All alumina is sent to the refineries of the three owners in the U.S. *Alpart* is the only company in which the government holds no equity position, *i.e.* it is entirely privately owned.

From the above it is clear that (a) the same transnational corporations that operate in the rest of the IBA countries also control the Jamaican industry; and (b) the components are vertically integrated, with alumina refineries and aluminum smelters on the U.S. mainland. The vertical as well as horizontal integration gives them considerable flexibility in reallocating production in response to changes in conditions that affect profitability. Next, the main cost and production characteristics of the Jamaican industry are considered. It turns out that production is dominated by its energy intensity.

Jamaica has no domestic source of energy. Jamaican energy consumption grew from 8.6 million barrels fuel oil equivalent (f.o.e.) in 1961 to 22.7 million barrels f.o.e. in 1973; and in the last year of cheap energy (*i.e.* 1973) imported petroleum provided some 87% of Jamaica's total energy needs. In 1981 one-third of the value of imports was made up of crude petroleum and petroleum products.

The structure of bauxite and alumina production is, also, energy-intensive. Fuel oil and electricity are required at each stage of aluminum production: for the mining and drying of bauxite, benefaction and calcination at the alumina stage, and electrolytic smelting to primary ingot. The largest proportion of energy is required at the final stage, as shown in Table 6.

In comparison to competing materials, aluminum is relatively more energy-intensive. This is clearly shown in Table 7. Because of the lack of a domestic energy source there is no aluminum smelting capacity in Jamaica, though the government is now planning to install a 140,000 ton per year aluminum smelter. This will be a joint venture with the government of Columbia. The smelter will be coal-fired, and will use coal imported from Columbia (*Journal of Commerce,* October 17, 1984).

During the era of cheap energy, the energy factor played a minor role in determining the exploitation of bauxite reserves worldwide. The growth of aluminum demand, especially in the industrialized world, was the main factor in the location of new aluminum smelters and the development of regional sources of bauxite. Growth in the North American Market for aluminum, which averaged 9 percent per year in the post-war period until 1974, made Jamaica very attractive, especially in view of the conflicts with the government of Guyana in the 1960s. The island's accessible reserves, and low inland transportation costs between mines and shipping terminals afforded Jamaican bauxite cost advantages over competing sources (namely Australia and Guinea) in supplying the fast-growing U.S. aluminum market.

On the official level, the U.S. government lent support to the extensive development of Jamaica's deposits. From the mid-1950s the U.S. government decided to rebuild the depleted strategic stockpile of aluminum after the Korean War and authorized the accumulation of larger supplies of Jamaican bauxite in excess of normal requirements. U.S. companies also benefited from the U.S. government's endorsement of the Western Hemisphere Trade Corporation arrangements, which allowed U.S. companies operating in Jamaica to reduce their U.S. tax liabilities. The Jamaican government played a constructive role as well by imposing a concessionary tax regime, which involved a low-tax, royalty system that provided direct incentives to domestic processing of bauxite. However, this was to change in the 1970s, when Mr. Michael Manley came to power. We will return to that in the next section. But before we do that, consider (a) how Jamaican output of bauxite and alumina grew up to 1975 and then declined *continuously,* and (b) how output in Brazil, Guinea and Australia grew at an amazing pace after 1975.

Jamaica's bauxite output, and bauxite and alumina exports are given in Table

Table 7

Energy Requirements for the Production of Selected Materials

	10^6 BTU per ton
Aluminium	244.0
Magnesium	358.0
Nickel	144.0
Primary Copper	112.0
Zinc	65.0
Steel Slabs	24.9
Glass Containers	17.4

Source: Kellogg, (1977)

8. An index of the volume of exports, with 1974 exports equal to 100, is also given. After the rapid expansion of exports up to 1974, the 1984 exports of bauxite are 43% below the 1974 peak, and the exports of alumina are 40% below the 1974 amount. In contrast consider the percentage change in bauxite production in Brazil, Australia and Guinea over their respective production levels in 1974 given in Table 9. The actual levels of production are given in Appendix Table A3.

The official government explanation for the fall in output is "low world demand for aluminium."[9] However this explanation is clearly not satisfactory, as output elsewhere has risen. Jamaica grossly miscalculated the output elasticity of the rest of the world. It took the companies just one year to cut Jamaican output by a quarter in 1975, and by as much as a third in 1976, compared to 1974. And even in the 1975–77 recession output in Guinea and Australia continued to expand.

The pattern of production that emerges is as follows. After the conflicts with Guyana and Ghana (Graham (1982)) in the 1960s, production was expanded in Jamaica. After 1974, bauxite production was first expanded in Guinea, then

Table 8

Jamaican Bauxite Output, Bauxite and Alumina Exports, and Export Indexes

	Bauxite mined (million metric tons)	Bauxite Exports (million metric tons)	Alumina Exports (million metric tons)	Index of Exports (1974 = 100)	
				Alumina	Bauxite
1952	0.346	0.240			3
1953	1.173	1.055	0.029	1	13
1955	2.688	2.183	0.187	6	27
1960	5.835	4.148	0.676	24	52
1965	8.651	6.784	0.732	26	85
1970	12.009	7.575	1.717	61	95
1974	15.166	8.000	2.806	100	100
1975	11.380	5.483	2.375	84	69
1976	10.296	6.284	1.623	58	79
1977	11.434	6.355	2.036	73	79
1978	11.736	6.448	2.142	76	81
1979	12.682	6.400	2.286	81	80
1980	13.298	7.356	2.640	94	92
1981	12.793	6.400	2.762	98	80
1982	9.187	4.929	1.937	69	62
1983	7.700	3.678	1.702	61	46
1984	8.570	4.540	1.690	60	57

Sources: Jamaica Bauxite Institute
Journal of Commerce

Australia, and finally in Brazil. As output expanded in these three countries, the production in Jamaica was cut back. It will be noted that in 1980 and 1981 exports came close to the 1974 peak. 1980 was the year when Mr. Manley's socialist government lost the election and Mr. Seaga's appeared to be 'pro private enterprise.' Perhaps the new government was expected to change the tax levy imposed previously by Mr. Manley. But as mined output did not recover, the increase of exports in 1980 and 1981 was an attempt to reduce previously accumulated inventories, or the increased exports reflect purchases by the U.S. government for its strategic stockpile of bauxite.[10]

IV

Jamaica's Tax on Recovered Ore

MR. MANLEY'S GOVERNMENT had been negotiating with the aluminum companies for an increased State share of the bauxite and alumina revenues, but effective 1st January 1974, it imposed a tax, called the Bauxite Production Levy, and broke off all negotiations.

The total revenue from the levy was given by the following formula:

$$\text{Levy Revenue} = \left[\frac{\text{bauxite exports in long tons}}{4.3} \times P_A\right] \times t$$

Table 9

Percentage Change in Bauxite Production Over 1974 in Selected Major Producer Countries.

	1975	1976	1977	1978	1979	1980	1981	1982	1983
Jamaica	-25%	-33%	-25%	-24%	-25%	-22%	-24%	-46	-52
Brazil	0	0	+50	+50	+80	+500	+500	+460	+460
Guinea	+0.5	+35	+43	+59	+59	+82	+68	+55	+51
Australia	+5	+20	+30	+22	+38	+36	+27	+18	+23

Source: Appendix Table A3

where P_A is the price of aluminum ingot in long tons and t was originally 7.5% in 1974 but was reduced to 6% in 1984. [The rationale for the denominator is that 4.3 is the number of long dry tons of Jamaican bauxite needed to produce 1 ton of aluminum.] The levy is payable in *U.S. dollars* for every ton of bauxite "deemed to have been exported or won." The price P_A is the realized price, as shown in the companies' Securities and Exchange Commission 10-K reports. The levy payments are reduced by 50% when production is over 70% of installed capacity.[11] Levy payments, which were made quarterly before 1984, were now to be made monthly.

Quite apart from the levy, the mining companies were required to pay a royalty of J$0.50 per ton of bauxite mined. In 1984 this was changed to US$0.50 per ton of bauxite, as repeated devaluations of the Jamaican dollar had reduced the royalty to 13 cents U.S.

When the levy was originally imposed in 1974, it raised government revenue per ton of bauxite by a factor of 6, see Table 10. Within one year of the imposition of the levy, bauxite output fell by 25% (as we have seen in Section III), *but* as the realized price of aluminum rose by about 17% (see Section II) government revenue fell only by about US$32 million, or about 18%. However, throughout the 1975-77 recession and after, Jamaican bauxite output fell, but at the same time bauxite production expanded elsewhere, as shown in Section III. That this redistribution of output was the result of the imposition of the levy cannot be

Table 10

Jamaican Bauxite Output and Government Receipts (levy + royalty)

	Bauxite Output (m tons)	Receipts (M US$)	Receipts/Ton (US$)
1970	12.0	36.5	3.04
1971	12.4	30.3	2.44
1972	12.5	27.6	2.21
1973	12.6	25.3	2.01
1974	15.3	187.3	12.24
1975	11.5	155.5	13.52
1976	10.3	130.2	12.64
1977	11.4	189.3	16.61
1978	11.7	195.2	16.68
1979	11.5	196.0	17.04
1984	8.6	250.0	29.17

Source: Jamaica Bauxite Institute

doubted. To quote the Vice-President of *Alcoa* (IBA *Newsletter,* No. 29, October 1977, p. 5):

> . . . as a result of the levies imposed on bauxite operations, particularly in the Caribbean,[12] the aluminium companies would in future concentrate their investments in bauxite operations in Australia and Brazil[13] because of the more favourable policies of these countries. . . . Such a shift in investment policy has even begun and it is based on economic considerations.

Reynolds went even further: in April 1984, it ceased mining bauxite in Jamaica altogether, as it had found alternative cheaper sources from its joint mining ventures in Australia, Brazil and Guinea (*Wall Street Journal,* February 19, 1984). In fact, according to the *Financial Times* of London (October 24, 1984) the five companies in Jamaica had spent 10 years criticizing the effects of the levy on their operations. By 1984, *Alcoa, Alcan, Kaiser* and *Reynolds* were resigned to the fact that the levy was there to stay (*Journal of Commerce,* April 24, 1984). While *Reynolds* has ceased mining, *Alcoa* has stated that it will close its 80,000 metric ton alumina plant.[14] Even the future of the 1.2 million metric ton alumina plant belonging to *Alpart* (the largest in Jamaica) is in doubt as *Atlantic Richfield* is divesting itself of its mineral assets. The remaining two partners (*Reynolds* and *Kaiser*) are unwilling to continue production unless a replacement is found for *Atlantic.*

Having considered the levy and its consequences, the rest of this paper is concerned with the implied criteria of the tax, and why in the particular circumstances of Jamaica, the tax was ill-conceived. To support the latter, four main arguments will be given.

The specifics of the levy are: payment in proportion to the realised price of aluminum as *disclosed* to the U.S. agency, Securities and Exchange Commision (SEC); payment in U.S. dollars; tax receipts to rise *both* with bauxite exports *and* with the price of aluminum. The critiera implied by these specifics seem to be (a) the maximization of tax revenue from the aluminum companies on the assumption that the price of bauxite charged by a vertically integrated multinational company is not an "arms-length" transaction, (b) stability of tax revenue, as it depends on the price which, as we have seen, has been very stable over very long periods (c) certainty of tax revenue, in the sense that the tax liability could not be disputed as it would be based on a realized price disclosed in a public document, and (d) administrative simplicity, *i.e.* low collection costs. While these are valid criteria, the levy totally ignored an important criterion in taxation, namely neutrality.[15]

The levy, like all *ad valorem* taxes, is non-neutral because it reduced the *net* marginal returns to the mine operator by raising the extraction costs by the value of the tax per quantity mined (Herfindahl and Kneese (1974), p. 121, or Garnaut and Ross (1983), p. 93). A non-neutral tax has two consequences that are relevant here. First the tax raises the 'cut-off-grade' of the ore mined.[16] This means some ore that would have been mined is now lost forever, so that total life-time mined output will now be smaller. Hence total discounted tax revenue obtainable over the life of the mine will also be lower. Second, given two locations of mines (say Jamaica and Australia), the one with higher net marginal returns will be exploited first.[17] The move from lower to a higher net return location will be determined by (a) the time required to start exploiting the new mine with a higher net return, *i.e.* the gestation period of the new investment; (b) the extent to which the capital equipment in the lower return mine has been written off; (c) the nature of the mining operation (open-pit or underground); and (d) the expectations of the mine operator as to whether the lower return due to a high *ad valorem* tax is temporary or not.

In the case of Jamaica, almost all of the bauxite mining is of the open pit type, and much of the machinery (drag lines, etc.) can in fact be physically moved to a higher return location. As far as expectations about changes in the tax structure are concerned, the aluminum companies waited for a new government in Jamaica and started to pull out when it became clear in 1984 that the Seaga government would not change the levy formula.

In spite of its non-neutrality, *ad valorem* taxes on minerals can be found in virtually every mining state within the U.S.A., Australia, the U.K., and many African countries (see, for example, Conrad and Hool (1980), Garnaut and Ross, *op. cit.,* or Peterson and Fisher (1977) and the references given in the latter). However, the *level* or the magnitude of the tax was so high that it made Jamaica uncompetitive with other producer countries.

Having considered the first argument against the levy (its non-neutrality), we turn to the second. It can be shown that the levy plus royalty per ton of bauxite mined amounted to US$11.99, which must be added to the average production costs and transportation. This brings the 1979 cost of bauxite, c.i.f. U.S. Gulf, to $32.53 per metric ton.[18] Thus the tax became the largest cost component of Jamaican bauxite. The tax per long ton of aluminum is $51.55, or 3.9% of the price of aluminum. This was nearly *twice* the 2% (of the price of aluminum) guideline agreed by the IBA in 1979 (see Section III above). In view of this the reallocation of output that occurred is not surprising.

The third argument is a comparison of this tax with the bauxite taxes in Australia. Bauxite is produced both in Queensland and Western Australia. In the latter, there is a royalty of A50 cents per ton of bauxite, and 25 cents per ton on alumina which rises with the world price of alumina. In Queensland the tax varies with the world price of aluminum ingot; the tax is A40 cents per metric ton times the ratio of the current *Alcan* world price to the 1973–74 price, provided that the tax is not less than A50 cents per metric ton of bauxite ore consumed within the state, and one dollar per metric ton consumed outside the state. In 1979 the Queensland tax works out at A$1.79 per metric to, or US$1.97. For the same year then, the Jamaican tax was more than 6 times the Queensland tax.

It is clear that the Jamaican levy plus royalty is far out of line with Australian taxes. At most Jamaica would have been able to exploit the differential in transportation costs between Australia and the U.S. and between Jamaica and the U.S.. From the data given in Pindyk (1977) this differential is no more than US$5.00 per ton, whereas the Jamaican tax (in 1979) is more than twice this figure. However the differential has more or less been eroded completely with the development of Brazilian bauxite exports.

The final argument is more compelling: it is that the Jamaican tax brought the cost of its bauxite closer to the cost of producing alumina from sources other than bauxite. Alumina can also be produced from high alumina clays, dawsonite, alunite and anorthosite, all of which are plentiful in the earth's crust. In the U.S. alone there are up to 10 billion tons of high grade clay with a 25 to 35 percent alumina content, and about 2 billion tons of alunite (37 percent alumina).[19] Thus about 88% of the world demand for bauxite which is used to produce aluminum would vanish.[20]

Pindyk (1977) estimated the critical price at which clay becomes competitive with bauxite for the production of alumina. His critical price was in 1976 U.S. dollars,[21] which we can update (by using the U.S. producer price index) to obtain the 1979 price. Then the critical 1979 price lies in the range $35.90 to $52.63, depending on assumptions about energy prices. Taking the upper end of this range, it can be seen that the cost of Jamaican bauxite is about 60 percent of this. The critical price is no doubt subject to error but most alternative plentiful sources (sometimes called 'backstop' technologies) such as electricity from nuclear fusion, minerals from the seabed, or oil from shale sands, would have production costs that would be several multiples times the least cost technology in use today. The essential point is the order of magnitude, and that has shrunk considerably after the imposition of the levy, because without a local energy source Jamaica was already a high cost producer compared to the U.S.

A further point to note is that the energy factor is double-edged: the higher is the price of energy the higher is the critical price; however the higher is the energy price the more competitive are the oil sands of the U.S.. If the oil sands are eventually exploited, then dawsonite, from which alumina can be produced, will be a by-product.

V

Conclusion

THIS PAPER ARGUES that the oligopolistic nature of the aluminum industry encouraged the formation of the IBA. However the companies, which were both vertically and horizontally integrated, evolved a successful strategy of exploration and time-phasing of bauxite production capacity worldwide. The high tax policy of the Caribbean members of the IBA was not followed by the other members of the IBA. The result was a fairly quick reallocation of production away from the very large Caribbean producer, Jamaica.

Jamaica attempted to extract, by imposing an *ad valorem* tax on bauxite, resource rents from vertically integrated companies that processed the Jamaican ore mainly in the U.S. and Canada. This tax was non-neutral; it raised the price of bauxite in relation to the price of aluminum to twice the rate recommended by the IBA guideline; it was out of line with taxes imposed by other large bauxite producers (*e.g.* the tax was 6 times the Queensland tax); it significantly eroded the cost differential between the cost of alumina made from Jamaican bauxite and alumina that can be made from non-bauxite sources such as alumina clays which are in abundant supply. Hence if Jamaica had been the world's only source of bauxite, there would have been a strong incentive to exploit the alumina clays and other sources of alumina. This would have made Jamaica's bauxite of no economic value, except perhaps for the small use of bauxite made by industries other than the aluminum industry.

It seems that the levy may have to be replaced by some form of a profits-based tax[22] (Garnaut and Ross, *op. cit.*), over and above the corporation tax, but the tax will have to be in line with bauxite taxes in Australia, Brazil and Guinea. That is, Jamaican bauxite will now have to *compete* with bauxite produced in these other countries. As the Jamaican subsidiaries are being used less and less as sources of supplies by the major corporations, the Jamaican government has stepped in to boost the sales of bauxite. It has made agreements to sell directly to the U.S. government for its strategic stockpile; it has engaged in bauxite counter-trade with U.S. automobile companies as well as food supply companies; and it has also made a seven year (1985–92) contract to supply the U.S.S.R. some 7 million metric tons of bauxite. But these are short term actions; the government will still have to find a more long term solution to restore production to capacity level.

There are other more pressing reasons why the mining crisis must be resolved. For a 15 year period up to 1974 per capita income in Jamaica grew at 3% per annum; for the following eight years per capita income *fell* at an average rate of 3% per year, so that in 1980 per capita income was 25% below its 1972 peak, or virtually where it stood 20 years earlier.[23] The fall in income has been accompanied by rapid inflation, high unemployment, sharp decline in domestic savings, negative international reserves, and an eightfold increase in foreign debt which exceeded 50% of Gross Domestic Product (GDP) in 1980. Traditionally bauxite and alumina account for three-quarters of Jamaica's merchandise exports, one-third of government revenues and one-seventh of GDP.[24] Jamaica's bauxite reserves are fourth highest in the world and would sustain 100 years of production at current rates of extraction.

After 1981, the negative trend of GDP has been reversed; but there is a long way to go.

Table A1

World Production of Aluminium
'000 short tons

	1976	1977	1978	1979	1980	1981	1982	1983
Total America	5,246	5,954	6,353	6,711	7,217	7,049	5,660	5,940
of which U.S.	4,251	4,539	4,804	5,023	5,130	4,948	3,609	3,696
Canada	692	1,073	1,156	952	1,184	1,232	1,174	1,203
Total Europe	3,684	3,811	3,870	3,962	4,144	4,105	3,890	3,927
Total Asia	1,502	1,799	1,667	1,614	1,729	1,456	1,131	1,073
of which Japan	1,013	1,310	1,166	1,114	1,203	849	387	282
Total Africa	372	406	371	442	482	532	552	477
Total Australasia[1]	410	433	457	467	506	590	604	766
Sub Total	11,213	12,404	12,717	13,196	14,079	13,733	11,838	12,184
Total Eastern Europe[2]	3,160	3,203	3,351	3,530	3,622	3,566	3,546	3,567
of which U.S.S.R.	2,425	2,425	2,535	2,590	2,668	2,646	2,646	2,646
TOTAL	14,373	15,607	16,068	16,726	17,700	17,299	15,384	15,751

1 Australia and New Zealand

2 Includes China and North Korea

Note: To obtain the equivalent in metric tons, increase all numbers by 10%.

Source: American Bureau of Metal Statistics, Non-Ferrous Metal Data 1983.

Notes

1. See for example, Wallace (1937); Stocking and Watkins (1946); L. Marlio (1947).

2. After the divestiture order it became *Alcan.*

3. *Metal Bulletin,* London, August 2, 1963.

4. *Metals Week* (August 9, 1971) reports the participating companies as being Alusuisse, Pechiney, VAW, British Aluminium, Montedison, Ranshojen Bernhorf, Holland Aluminum, and Guilini.

5. A full study of the differential profitability of copper and aluminum companies is beyond the scope of this paper.

6. In fact the six majors operate in *all* bauxite producing countries, except Yugoslavia and Guyana, where bauxite is mined by government-owned enterprises.

7. And yet the average price of aluminum *rose* by 17% in 1975 over the previous year (see Table 1).

8. As from February 1980, see *Metal Bulletin,* April 1981.

9. See, for instance, the *Financial Times* of London, February 20, 1985.

10. After Mr. Seaga came to power in 1980, the U.S. has made several purchases of bauxite at prices that were considerably above world prices. This no doubt also helped to improve relations between the Reagan administration and Jamaica.

11. The General Manager of Alpart, Mr. Jerome Broussard, is reported to have said "the incremental cost of reaching this production level is too great." Their plant has been running at 50% of capacity for the last two years (*Financial Times* of London, October 24, 1984).

12. A tax very similar to the Jamaican Levy was imposed by Guyana and the Dominican Republic, both members of the IBA.

13. Alcoa is continuing to expand the capacity of its aluminum refinery in Brazil; in 1985 its capacity was scheduled to be 110,000 metric tons, and by 1986 it was expected to be 245,000 metric tons (*Journal of Commerce,* November 16, 1984).

14. *Financial Times* of London, February 8, 1985.

15. Aspects of the taxation of exhaustible resources are discussed in Dasgupta and Heal (1979), Dasgupta, Heal, and Stiglitz (1980), Garnaut and Ross (1975, 1983), Simmons (1977), and Palmer (1980).

16. Let α^* be the cut-off grade. As long as a particular grade of ore contributes more to revenue than to costs, the ore is worth mining. *i.e.* $\alpha^* = \frac{MC_\tau}{MR_\tau}$ where MC_τ is marginal cost at time τ and MR_τ is the marginal revenue at time τ. If the market is competitive $MR_\tau = P_\tau$, the price at time τ. An *ad valorem* tax t reduces the net marginal revenue by $(1 - t)$. Then $\alpha^* = \frac{MC_\tau}{(1 - t)MR_\tau}$.

17. This elementary propostion is demonstrated in Herfindahl and Kneese, *op. cit.,* p. 123.

18. The entire calculation of the levy must be done in long tons, as it is assumed by the tax that it takes 4.3 *long* tons to produce 1 ton of aluminum. The price of aluminum in 1979 was US\$0.5935 per lb., multiplied by 2240 = \$1330.45 per long ton. The exports in 1979 of 6.4 metric tons × 0.9839 = 6.297 million long tons. Divide this figure by 4.3 and multiply by \$1330.45, and 7.5% of this gives the total levy receipts of US\$146 million. To this must be added the royalty which in 1979 was 12.68 million × J\$0.5, which must be converted to U.S. dollars at US\$1 = J\$1.7814. The total levy plus royalty divided by 12.68 million gives \$11.99 per metric ton of bauxite mined.

Table A2

World Consumption of Primary Aluminium
'000 short tons

	1976	1977	1978	1979	1980	1981	1982	1983
Total America	5,748	6,089	6,390	6,527	5,920	5,486	4,850	5,460
of which U.S.	4,950	5,243	5,487	5,521	4,910	4,564	4,021	4,640
Total Europe	3,821	3,852	3,944	4,277	4,276	3,897	4,036	4,162
of which West Germany	1,052	1,006	1,050	1,177	1,149	1,126	1,102	1,213
Total Asia	2,330	2,240	2,596	2,723	2,564	2,571	2,658	2,840
of which Japan	1,774	1,565	1,826	1,986	1,807	1,731	1,804	1,986
Total Africa	126	139	153	166	189	206	207	188
Total Australasia[1]	206	213	228	265	270	287	267	244
Sub Total	12,230	12,533	13,311	13,959	13,220	12,447	12,018	12,894
Total Eastern Europe[2]	3,311	3,472	3,652	3,716	3,718	3,644	3,648	3,692
of which U.S.S.R.	1,863	1,940	2,017	2,059	2,039	2,050	2,072	2,072
TOTAL	15,540	16,005	16,962	17,675	16,864	16,094	15,710	16,598

1 Australia and New Zealand

2 Includes China and Cuba

Source: American Bureau of Metal Statistics, op. cit.

The average production cost in 1979 was US$14.25, f.o.b. Thus the total cost per ton is:

production cost	$14.25
+ levy and royalty	11.99
+ transportation	6.29
	US $32.53

19. U.S. Bureau of Mines and other sources quoted in Pindyk (1977), who also states that there are about 18 known alternative processes by which alumina could be produced from clay. Capital and operating costs of two of these processes are also given.

20. That is, if the U.S. is representative of the structure of world demand. In the U.S. the remaining 12% of bauxite is used in chemicals, refractories and abrasives (Pindyk (1977)).

21. Pindyk's range of the critical price was $26.73 to $31.19 per metric ton, in 1976 dollars. In this estimate, he allowed for further increases in the price of oil. His own estimate is also an updated version of 1973 prices estimated by the U.S. Bureau of Mines.

22. As to what would be an appropriate resource rent tax under conditions of oligopoly cannot be analyzed here.

23. Source of the data; United Nations (1983).

24. This of course does not include the illegal export to the U.S. of Jamaican marijuana, which has an estimated street value of US$1.4 billion a year, or twice as much as Jamaica's combined earnings from the legitimate pillars of the economy—bauxite and tourism. The estimated value of the Jamaican cash crop of marijuana is about US$3.5 billion a year, which is more than Jamaica's official Gross National Product (*Financial Times* of London, October 24, 1984).

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Table A3

Major Bauxite Producing Countries of the World
in Millions of Short Tons

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Jamaica	13.8	14.3	14.9	16.8	12.4	11.3	12.6	12.9	12.7	13.2	12.8	9.2	8.1
Brazil	0.6	0.8	0.9	1.0	1.0	1.1	1.5	1.5	1.8	4.5	5.1	4.6	4.6
Guyana	4.7	4.1	4.0	3.9	4.1	3.4	3.7	3.8	3.7	3.7	2.6	1.9	1.9
Surinam	7.4	7.5	7.6	7.6	5.3	5.0	5.4	5.6	5.2	5.4	4.4	3.3	3.1
Guinea	2.9	3.0	4.1	8.4	8.4	12.5	12.0	12.8	14.7	15.3	14.1	13.0	12.7
Australia	14.0	15.9	19.4	22.0	23.1	26.5	28.8	28.6	30.4	30.0	28.0	26.0	27.0

Source: American Bureau of Metal Statistics, Non-Ferrous Metal Data, various issues.

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The Pattern of Neocolonialism

By RAYMOND E. CRIST

I SPENT THE YEARS 1928–1931 in geological investigations along the Llanos-Andes border in Venezuela and summarized my observations in the *Geographical Review.* In 1954, I spent a summer field season in the same area to record some of the changes in the cultural landscape that had taken place during the intervening years.

In 1982, I revisited the sector to chronicle some of the changes that have taken place during the last quarter century, to collate observations made over