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ZAMBIA'S DECLINING COPPER OUTPUT

by

Luka Powanga

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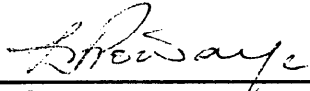
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A thesis submitted to the Faculty and the Board of Trustees of the Colorado School of Mines in partial fulfillment of the requirements for the degree of Master of Science (Mineral Economics).

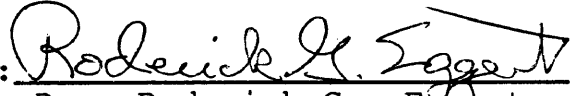
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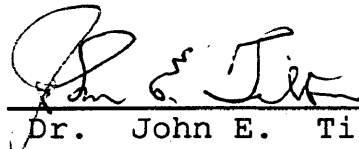

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ABSTRACT

Zambia's economy is heavily hinged on its copper industry, the only significant source of foreign exchange. Zambia is currently the world's fifth largest producer and second largest exporter of copper. The mining sector is the primary determinant of Zambia's economic and financial performance. Traditionally, the copper industry has accounted for more than 50 percent of the internally generated government revenue and over 95 percent of Zambia's foreign exchange earnings.

Since 1976, Zambia has faced serious financial problems due to a steep decline in copper production resulting in low revenues to the mining industry and depressed government income. Production by Zambia Consolidated Copper Mines Limited (ZCCM), the only mining company in Zambia, fell from 709,000 tonnes in 1976 to 463,000 tonnes in 1986. The purpose of this study is to determine the factors responsible for this sharp decline.

The fall in production was caused by a host of factors. These factors include political factors, labor unrest, poor investments in operations, physical disasters, declining ore quality, transportation bottlenecks and prolonged periods

of depressed copper prices. Among these factors, the most important were poor investments, depressed prices, transportation problems, poor ore quality, and political factors. Labor unrest and physical disasters played minor roles in suppressing Zambian production.

However, in spite of all these problems, the future prospects for the Zambian mining industry are promising. Copper prices have improved tremendously, and the mining company and the government have initiated several measures to address the operational cost problems. The measures include restructuring and rehabilitating the TAZARA (Tanzania Zambia Railway Authority), the most important outlet to sea, and a tax break granted to the mining industry by the government. Through these and several other efforts, the company will be able to lower its costs and increase its production and profits.

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Chapter 1

INTRODUCTION

Zambia occupies 285,000 square miles with a population of over 6 million. Landlocked, it shares borders with Angola, Malawi, Mozambique, Zimbabwe, Zaire and Botswana (Figure 1.1).

Zambia, formerly Northern Rhodesia, gained independence from British colonial rule in October 1964. Until 1924, when the British government took direct rule over the territory, it was controlled by the British South Africa Company (BSA) under a charter granted it by Great Britain. In 1953, the federation of Rhodesia and Nyasaland, consisting of Zambia, Zimbabwe, and Malawi, was formed under the leadership of a British governor. Black political pressure broke the federation in 1963 leading to Zambia's political independence (Nziramasanga and Obidegwu, 1981).

Mineral prospecting started in 1902 but gained momentum in 1923 when large companies received rights from the BSA to prospect over large areas. The Rhodesia Selection Trust (RST) and the Anglo American Corporation emerged as the two major mining companies (Cunningham, 1981).

At independence in 1964, the relationship between the mining companies and the new government became strained as

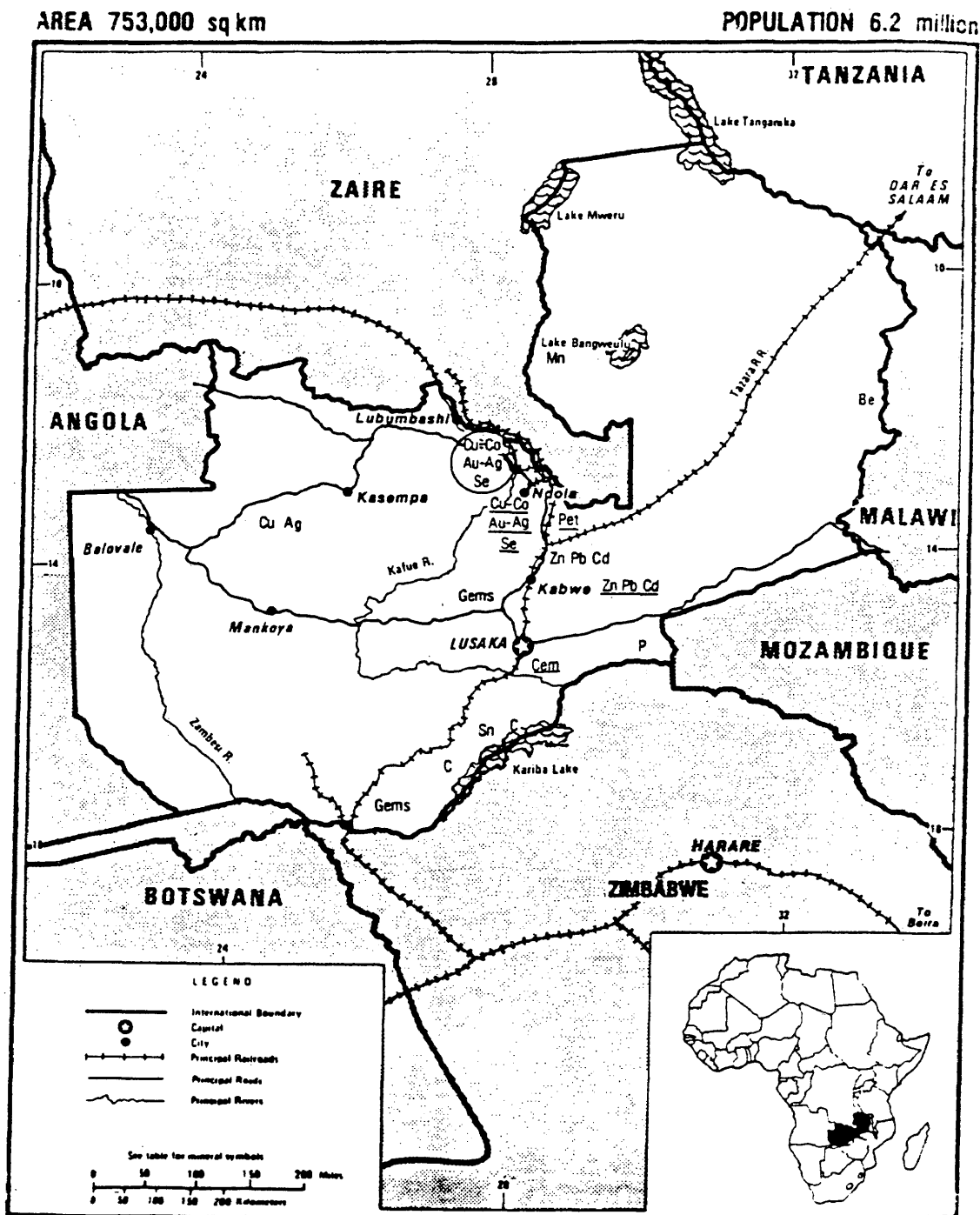


Figure 1.1. Zambia and Her Neighbors.

Source: U.S Bureau of Mines. 1984. Mineral Industries of Africa. Washington D.C.: GPO.

each tried to maximize its own objectives culminating in the takeover of the major ownership and control of the industry, on which the Zambian economy is so heavily hinged, by the government in 1970 (Nziramasanga and Obidegwu, 1981).

Up until 1970, Zambia was ranked as the third largest producer of copper in the world after the United States and Russia. However, this position has been relinquished and Zambia now ranks fifth after Chile and Canada, a direct consequence of the falling copper production in Zambia (Zambia Mining Year Book and ZCCM Annual Report, various issues).

The Zambian copper mining operations encompass all stages of production from mining to electrometallurgical processes to end up with fine (refined) copper. The Zambian fine copper production (Table 1.1. and Figure 1.1.) declined from 696,000 tonnes in 1965 to 623,000 tonnes in 1966. Thereafter production improved hitting an all time high of 720,000 tonnes in 1969, and declining to 636,000 tonnes in 1971. Except for the period between 1973 and 1975 when the output was depressed, production generally increased between 1971 and 1976. However, from 1976 to 1986, Zambian copper production deteriorated sharply from 709,000 tonnes in 1976 to 463,000 tonnes in 1986, a decline of 35 percent.

Table 1.1. Mine Production of Copper

<u>Year</u>	<u>Output</u> (000's of tonnes)
1965	696
1966	623
1967	663
1968	685
1969	720
1970	677
1971	636
1972	701
1973	707
1974	698
1975	677
1976	709
1977	656
1978	643
1979	585
1980	596
1981	588
1982	592
1983	576
1984	551
1985	526
1986	463

Source: Metal Statistics. Annual 1987. Zambia Mining Year
Books. ZCCM Annual Reports.

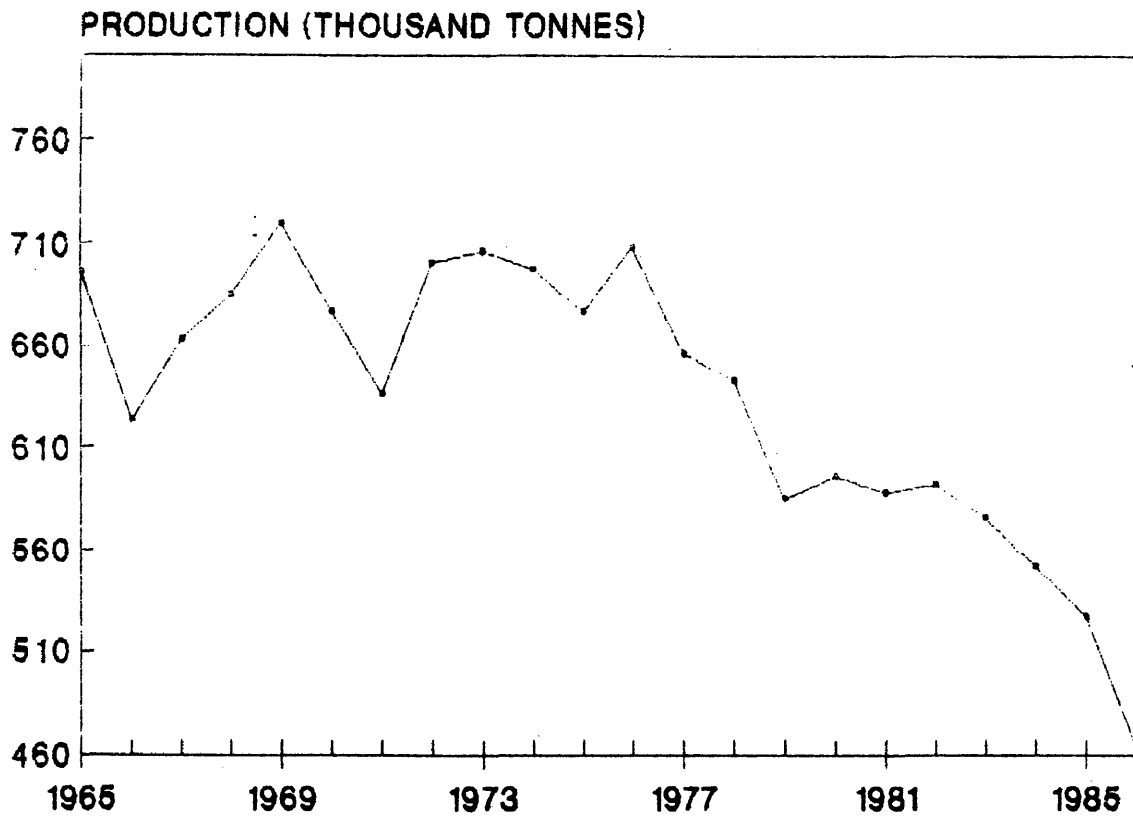


Figure 1.2. Zambian Copper Production Trends

Source: Table 1.1.

Several theories have been advanced by academicians and professionals alike to explain this sharp decline in Zambian copper production. Omitting the multitude of factors whose impact may be insignificant, the potential determinants of the low copper output from the Zambian mines include heavy taxation of the mineral industry by the government, declining ore grades, poor investments in the mining operations, and nationalization of the mines.

The purpose of this study is to determine which of the above factors or others were responsible for the decline in the output of the Zambian copper mines since 1976. These factors will be studied under geologic factors (including physical disasters), economic factors, and political factors.

Chapter 2 will discuss the geologic factors. The impact of declining ore quality and economic exhaustion of reserves on production over time will be examined. The contribution of physical disasters to the fall in copper output will also be studied.

Chapter 3 will address economic factors. The trend in real prices and how this has affected copper output from the Zambian copper mining industry for the period under review will be examined, including the impact of the instability in transportation routes on copper production.

Chapter 4 will provide an analysis of the influence of political factors on the performance of the industry. These factors will include the major ownership and control of the mining industry by the Zambian government and how this position has affected labor productivity and production. Taxation policies will also be examined.

Chapter 6 will evaluate the relative importance of the factors discussed separately above, and then examine the implications of these results for Zambian copper production.

Chapter 2

GEOLOGIC AND NATURAL DISASTER FACTORS

2.1 Declining Ore Quality

The foremost geologic factor that may be responsible for the declining copper output in Zambia is the quality of the ore. Ore quality which includes ore location, ore grade, and chemistry of the ore, plays an important role on the costs incurred at various extraction stages. For instance, a sulphide ore consumes much less energy than a silicate ore (Tilton, 1987).

Declining ore quality increases the difficulty of accessing the ore. In many cases, stripping of overburden in open pit operations is slowed significantly, resulting in reduced production. In the case of underground operations, development and production performance becomes suppressed. Therefore, a decline in ore quality will result in higher costs leading to a leftward shift in the supply curve. Production will be depressed. Owing to the absence of an ore quality index data, it is difficult to tell whether the quality has declined over the period under consideration. Therefore, most of the discussion will be based on ore grades.

Because the information is fragmentary, the impact of

ore quality and declining ore grades on copper output will be assessed for the period 1976 to 1986 (Table 2.1.).

Except for 1977, Zambian ore grades generally declined over the period 1976 to 1986. The weighted average ore grade in 1977 at 2.56 percent was higher than the previous year's ore grade of 2.45 percent. In spite of this increase 1977 production fell below the 1976 level. The low output was mainly caused by a big drop in ore grade at Luanshya mine and problems with the ore quality. The resultant dilution in ore delayed development and production at this mine (USBM, 1977) because of the difficulty in obtaining the right grade for the mill input.

At the same time, production was hampered at Rhokana mine by wet ore. The impact of low ore grade and ore conditions at these two mines (which contribute 30 percent of the total ore mined) caused a decline in output of 280,000 and 335,000 tonnes for the Luanshya and Rhokana divisions respectively, a combined drop of 6 percent in 1977. Production from the rest of the mines was not sufficient to offset the impact of low output from these mines (Luanshya and Rhokana mines).

The subsequent drop in ore grades from 1977 to 1984 adversely affected the mining operations. Because of the relative difficulty in accessing the ore and getting the desired grade for the mill feed caused by dilute ores,

Table 2.1. ZCCM Copper Ore Grades

<u>Year</u>	<u>Ore Mined</u> (000's of tonnes)	<u>Grade (%)</u>
1975	33,960	2.44
1976	33,680	2.45
1977	32,451	2.56
1978	30,807	2.44
1979	N/A	N/A
1980	32,495	2.35
1981	30,498	2.29
1982	29,828	2.23
1983	31,990	2.21
1984	29,769	2.13
1985	27,966	2.23
1986	24,413	2.21

Source: ZCCM Financial Analysis Department. U.S Bureau of Mines (USBM). Minerals Yearbook. Vol. 3, Area Reports (various years). Washington D.C.: GPO.

development and production at most of the underground mines, notably Nchanga, Luanshya, Konkola, and Rhokana, was delayed and fell behind schedule during most of the period. In open pit operations, overburden stripping was below target, especially at Nchanga open pit, the biggest contributor to Zambian copper production.

Consequently, apart from a slight peak in 1980 and 1982 when production went up marginally, production declined. Therefore, the decline in production during this period was at least partly attributable to declining ore grades. In the subsequent period between 1984 and 1986, production continued to drop (see Table 1.1.). During this period ore grades improved slightly. The improvement in ore grades was not sufficient to boost production.

From the foregoing discussion then, it can be said that deteriorating ore quality has played an important role in the fall of Zambian output. The declining ore quality has affected the Zambian copper output adversely. The poor ore quality has led to increased costs per tonne of copper produced because more ore is being treated to produce one tonne of copper. Delays in production are experienced because of the added difficulty in accessing the ore. In addition, because of the limited milling capacity, the decline in ore quality has caused a decline in production.

Poor ore quality is therefore responsible for the fall in production during the period 1976 to 1986.

The problem of deteriorating ore quality will continue to affect the copper output from Zambian mines because there is no evidence of new deposits with richer ores. Though the declining ore quality is outside the control of both the mining company and Zambia, its effect can be reduced by employing modern extraction and processing methods that will allow for treatment of dilute ores. For instance, the traditional hydrometallurgical processes can only treat feed in excess of 25 percent acid soluble copper so that after the leaching process the leach liquor contains about 40 to 45 grams of copper per liter of liquor. This means that the feed has to be upgraded prior to being introduced into the leach circuit. With the current solvent extraction method, which can treat decant solutions as dilute as 2 grams per liter of liquor, leachable ore from underground or open pit operations can be introduced directly into the circuit without going through intermediate stages.

Such methods not only save on costs but also allow for discarded material to be reclaimed and recirculated.

2.2 Ore Reserves

Ore reserves are by definition those portions of known copper deposits which can be exploited economically at prices in effect and the technology in use at the time of determination. Reserves are helpful in determining the relative sizes of the mines and are a good warning bell for a mine nearing exhaustion. Ore reserves can contribute to a fall in production. As production progresses operating mines that have reached their economic life will close down and fewer reserves will be available for exploitation resulting in a fall in production.

Zambian mines experienced a significant drop in ore reserves after 1976 (see Table 2.2.). Before 1976, ore reserves were on the increase. In 1970 total reserves stood at 698 million tonnes and increased to 784 million tonnes in 1975. After 1976 the story changed dramatically as this tonnage declined by 45 percent to 425 million by 1984.

As opposed to the period before 1976, when many mines were coming on stream thereby sustaining production to the point of increasing it, the period after 1976 saw a series of closures as shown in Table 2.3. and discussed below.

In 1976, production at Mindola open pit was temporarily halted in January and resumed in June at lower output levels in anticipation of economic exhaustion. The low production

Table 2.2. Ore Reserves

<u>Mine</u>	<u>Year</u>	<u>Reserves</u> (000,000's of tonnes)	<u>Life</u> (in years)
Nchanga	1970	235	24
	1975	285	29
	1980	281	28
	1984	126	13
Konkola	1970	94	56
	1975	123	73
	1980	186	111
	1984	53	32
Nkana	1970	130	34
	1975	118	31
	1980	118	31
	1984	84	22
Luanshya	1970	72	21
	1975	72	21
	1980	57	17
	1984	43	13
Mufulira	1970	136	29
	1975	144	31
	1980	115	24
	1984	93	20
Chambishi	1970	31	15
	1975	42	21
	1980	34	16
	1984	12	12

Source: ZCCM Annual Report. 1984.

Table 2.3. Mine Opening and Closures

<u>Year</u>	<u>Mine</u>	<u>Event</u>
1970	Kalengwa	Opened
1971	Bwana Mkubwa	Reopened
1973	Baluba	Opened
1974	Kansanshi	Opened
1976	Mindola open pit	Closed/opened*
1978	Chambeshi open pit	Closed
1980	Kalengwa	Closed
1981	Mimbula and Fitula	Closed
1982	Bwana Mkubwa	Closed

Source: ZCCM Financial Analysis Department

* Closed in January and resumed operations in June at reduced production rates.

rate did not significantly affect the total ZCCM output because the output from this mine contributes less than 1 percent of the total output.

In 1978, open pit operations at Chambishi mine, accounting for 3 percent of the total ZCCM mine production, were discontinued because the ore reserves had reached the end of their economic life leading, to a 850,000 tonne decline in mine production. The reduction caused by the closure of these operations led to a reduction in copper output in 1978.

Another open pit mine, Kalengwa mine, with a capacity of 150,000 tonnes closed down in 1980 because of exhaustion of the reserves. The impact of this closure on production may have been very insignificant because mine production from this mine accounted for less than 1 percent of Zambia's total copper output. Consequently, fine copper production in 1980 did not fall. Instead, the output improved.

In 1981, Mimbula and Fitula open pits also folded their operations on account of exhausting the ore reserves. These two mines together contributed about 3 percent to the total ZCCM mine production. Because of the closure, production declined in 1981.

Bwana Mkubwa mine which produced about 2 percent of the total mine output was taken out of commission in 1982

(ZCCM Annual Report, various issues). In spite of the loss in production as a result of this closure, the overall production from the Zambian copper mines improved in 1982.

The reduction in production arising from exhausting the ore reserves has affected overall production since 1976 particularly 1981-1982. Though, in many instances the closures did not have any effect on the combined production from all divisions owing to their meager contribution to the total mine output, the rate of closures is alarming. The closures have far-reaching implications on future production. As there are no additions to the stock of reserves that the Zambian mines have, it is likely that the output will continue to decline as more and more operating mines close. To get around this problem, it is necessary that exploration efforts be increased so that new ore deposits can be discovered or additional reserves associated with known ore bodies can be discovered and developed.

2.3 Physical Disasters

Physical disasters, mainly mine accidents, can profoundly influence output. When an accident occurs, the affected section usually experiences long down times. In some cases, the mining methods have to be changed to avoid a similar incident from recurring or to operate profitably.

This implies that the capital that could otherwise have been used for expanding the operational facilities and improve production is used for repairs.

Sometimes, in spite of the heavy expenditure for repairs, preaccident production is never reached. In short, the long downtimes and the diversion of funds from other capital projects to rehabilitate the accident area tends to disrupt and reduce production because for the same production, more capital costs are incurred, pushing the marginal costs up and shifting the supply curve to the left. This movement in the supply curve results in low output.

Though the Zambian copper mines were for a long time relatively free from any sudden interruptions to production arising from floods, cave-ins, or explosions, Chibuluma mine suffered a major inflow of water in September 1966. Even though the downtime for the dewatering process to rid the mine of water and mud was only three months, full production was never recovered. Production of finished copper at this mine fell from 22,659 to 17,641 tonnes, 1 percent of the total finished production (Cunningham, 1981 and ZCCM Annual Report, various issues).

Four years later in September 1970, at Mufulira mine, another operating division of the mining company, a block-caving operation loosened the overlying tailings dump

and flooded the mine with pulverized material, claiming the lives of 89 miners. This was one of the worst disasters in the history of Zambian mining. Production fell from 165,000 by an estimated 125,000 tonnes of fine output in the first year, a drop of 17 percent of Zambia's fine copper output. Even after rehabilitation, production continued below the preaccident production levels. Before the accident, this mine carried the lowest cost in Zambia and was the largest underground mine (Cunningham, 1981 and ZCCM Annual Report, various issues). Consequently, production from the Zambian mines declined during this year.

The contribution of the Mufulira disaster to the fall in production of the Zambian copper mines was limited to 1971. The commissioning of Kalengwa mine in 1970 partially offset the effect of the accident. The offsetting impact was increased further in 1971 when Bwana Mkubwa mine reopened. With the commencement of partial production in 1972 at Mufulira mine, this tonnage, combined with that from the two newly opened mines, was sufficient to completely cushion the impact of the cave-in. This is the reason why production increased in 1972.

The pre-1976 period, though faced with physical disasters, did not experience a downward trend in production because either new mines were being commissioned or old mines

were being reopened. Consequently, the impact of reduction in production arising from physical disasters was buffered by the expansion in capacity. During the post-1976 era, no mines opened or reopened. Physical disasters had longer lasting impacts on production than before. The post-1976 physical disasters are discussed below.

In 1977, a heavy downpour caused flooding at the Nchanga open pit and underground mines. Production of ore from the eastern high grade areas of the lower ore body in the underground mine was restricted until September, and the high grade zones of mineralization in the open pit remained inaccessible at the end of the year. Even though efforts were made to maintain production by drilling alternative areas of slightly lower grades in both open pit and underground operations while dewatering and rehabilitation work was in progress, a fall in production of 581,000 tonnes representing over 2 percent of ZCCM output was experienced in 1977 at this mine, leading to a decline in Zambian total copper output (USBM, 1977). Later, the production shortfall was compensated for by the output from Fitula and Mimbula mines before the problem was finally resolved following the rehabilitation of the Chingola West Mill in 1980.

Another disaster was the fire at the Nkana Division power station in November 1982. The fire was started when a

3.3 KV cable end box developed an electrical fault on an 11/3.3 KV transformer and burst into flames. Both the 3.3 KV and 11 KV power cables were destroyed causing a protracted interruption to power supply. The accident immobilized the smelter operations as well as other surface facilities, severely constraining acid production at Nkana acid plant. During this period, the Nchanga Tailings Leach Plant which receives acid from Nkana for its leaching operations was down for a month from November and production of finished copper declined by 16,335 tonnes, representing over 3 percent of all finished production (ZCCM Annual Report, various issues). This disruption in operations resulted in a decline in production in 1982.

However, apart from the flooding of the Nchanga underground and open pit mines, the rest of the disasters had a temporary effect on production. Production was expected to improve apart from the affected years. Therefore, physical disasters do not explain the decline in production from 1976. However, the fall in production arising from physical disasters occurred in 1977 and 1982.

Physical disasters, though not new to mining operations, are within the control of the mining industry as well as the Zambian government. With strict safety standards administered through the Ministry of Mines and the company's

safety department, the risk of having any accidents can be reduced to a minimum. Zambian mines are fairly old and most of the hazardous places have already been identified.

 The government must act as a watchdog to ensure that safety standards are adhered to. It should be noted that the safety standards have been extremely high particularly since the Mifulira disaster. In spite of the capital expenditures that go with maintaining such high standards of safety, the safety levels have in fact been increasing. Because of the high degree of safety in working areas and the fact that most of the trouble spots have been identified, long term production losses arising from accidents can probably be ruled out.

CHAPTER THREE
ECONOMIC FACTORS

3.1 Price Fluctuations

Zambia's finished copper is priced at the London Metal Exchange which is a competitive market since neither the individual buyers nor the sellers are known to influence price levels. The free-market nature of the pricing system implies that the price of copper is given and Zambia is a price taker since it cannot for any length of time influence the price by changing its output.

The price of copper plays a very important role in the copper industry's capacity utilization. Capacity utilization is based on the relationship between the copper price and the cost of production. The company will produce at a level at which the marginal cost equates to the price. This follows from the theory of the firm which says that capacity will be utilized up to a point where the demand curve (price curve since it is horizontal to the company) and the marginal cost curve of the industry intersect. For the Zambian mines, in spite of the multitude of objectives that the company has including maximizing revenue and providing employment, this model is roughly correct if labor costs are assumed fixed (Kaufmann, 1986).

Therefore, in the event of the real price going down and the marginal cost remaining constant, a decline in production will be experienced because the production level will adjust to the new price level.

The prices have been quite volatile. From Table 3.1., the prices increased rapidly between 1965 and 1966 and went down substantially in 1967, rose steadily until 1969, went down in 1970, and started rising again reaching the highest mark in 1974. Thereafter, the prices were generally low until 1985 after which a substantial increase in prices was experienced in 1986.

Between 1967 and 1975, the average price of finished copper per tonne was K 1,969 (For converting from Kwacha to dollars, see Appendix) while for the period from 1976 to 1984, the average copper price declined to K 1,595. To assess the impact of prices on Zambian copper output, it is necessary to examine the supply curve in both short-run and long-run terms. The shape of the supply curve will determine the influence of prices on the output.

The Zambian copper mines have a multitude of objectives. Among these objectives is the provision of employment. Therefore, labor costs tend to be fixed rather than variable. The short-run supply curve in this case is different from the traditional supply curve which recognizes

Table 3.1. Real Copper Prices

<u>Year</u>	<u>Price</u> (Kwacha per tonne of copper)
1965	2,522
1966	2,818
1967	1,828
1968	2,210
1969	2,522
1970	2,134
1971	1,847
1972	1,578
1973	2,006
1974	2,200
1975	1,400
1976	1,775
1977	1,623
1978	1,549
1979	1,807
1980	1,803
1981	1,357
1982	1,117
1983	1,699
1984	1,626
1985	4,100
1986	4,479

Source: Metal Statistics. Annual 1987.

1980=100. Zambian GNP deflator used.

labor costs as variable costs. Under variable labor costs, the supply curve tends to be very responsive to price changes as long as the mine operations are not approaching full capacity. In the short-run the adjustment of supply to price changes is limited by the capacity. Near full capacity, mine production becomes inelastic to any price increases.

However, when labor costs are considered fixed, the supply curve tends to be inelastic to price changes in that only the maintenance costs account for variable costs. Therefore, even though the mine may not be operating at near full capacity, supply will be inelastic to price. Wide fluctuations in prices will generate very small changes in output.

The story is different in the long run because there are no fixed costs; the industry has sufficient time to adjust to changes in price conditions. In the long-run, there is ample time to develop new mines and processing facilities or to close down unprofitable operations. Hence, production will be elastic to price changes because a producer has an incentive to increase or reduce the output to a point where the marginal cost of production equates with the unit price.

From the foregoing discussion, depressed prices after

1976 affected Zambian output in the short-run in an indirect way rather than directly. The low prices did not affect copper production in the short-run because in the short-run a firm will continue to operate as long as variable costs are covered. And since labor costs are considered fixed, the variable costs represent a very small figure. It is therefore the author's opinion that during the period under consideration, the copper prices were always above the variable costs and therefore affected production only indirectly.

In the long-run, the low prices that prevailed during the post-1976 era affected the mining operations in two important ways. First, the depressed prices forced Zambia to adjust production so that it could produce at economic levels. Consequently, some mines were either closed or put on maintenance and care. Second, the low prices caused lower profits in the mining industry. Therefore, less foreign exchange was available for investment in mining operations and purchases of spare parts. The mines were forced to settle for crude spare parts refurbished within the plants. The equipment and machinery efficiency and availability became low, causing capacity to shift inwards.

Because of the inward shift of the supply curve, the

short-run capacity constraint has over time moved to the left to lower outputs. In this way, even in the face of high prices, production will not improve beyond this new capacity. This is the reason why Zambia's output has not improved in spite of the prices having doubled over the past two years even though Zambia was capable of producing 700,000 tonnes prior to 1976. Over time, this capacity has been reduced to 500,000 tonnes.

A devaluation of the kwacha will change the location of the supply curve. When the local currency is devalued, the receipts in dollar terms will remain unaffected (since all the copper produced is sold outside the country), while the costs incurred in local currency will decline in dollar terms, allowing Zambia to produce more copper. However, since Zambia is import-oriented and most of the inputs to the mines are imported, a devaluation will not result in a significant reduction in operational costs.

Reverting to the impact of prices on production, it can be concluded from the presented scenario on the nature of the Zambian supply curve that prices have not directly affected Zambian output in the short-run. The low prices have depressed profits. Consequently, investments in mining operations have diminished causing the productive capacity to shrink and in turn, affecting

short-run output.

The low prices were caused by the oversupply of copper in the years after 1974 as well as deceleration in copper demand. The high prices that existed in 1974 and the previous years attracted investments in copper projects. The copper industry has extended gestation periods for investments. Eight years or more can collapse between the time that a decision is made to start a large mining operation and the time that it comes on stream. By the time the message was received that the long run trend in metal consumption had taken a downward shift, many projects were already underway. A lot of money had been spent on them such that it was economical to complete them rather than abandon them. The copper industry ended up with a higher ability to supply copper than was demanded and that drove prices down. The prices fell to a level where productive capacity remained unused since the marginal cost of production exceeded the price. Consequently, the quantity supplied equalled that demanded, with a lot of capacity remaining unused.

The additional capacity that matured after 1974 may have been built based on the annual copper demand growth rates prior to 1974. However, following 1974, the copper demand growth rate deviated from this pattern and followed

much lower linear trends (Roberts, 1988). This is the reason why copper experienced a downward shift in the demand and the subsequent low prices and excess capacity in the period after 1976. Otherwise if the growth rate in copper consumption had remained static, this problem of low prices and depressed demand could not have surfaced (Roberts, 1988).

Deceleration in copper demand has been caused by a reduction in the growth of world economic activity (Gross Domestic Product) and the problems outlined below (Tilton, 1987).

(a) Material for material substitution, where one material is substituted for another, has provided a steady replacement of copper by other cheap materials. For instance, the development of stainless steel reduced the importance of copper as an anticorrosion material.

(b) Sacrificing quality by reducing the amount of a material in the final product. This is another way in which copper consumption has been reduced.

(c) Technological substitution, where a product innovation is brought about as a result of an improvement in technology. Such innovations have reduced the amount of copper in final product.

Additional problems have also contributed to the

deceleration in copper demand. A large proportion of copper ends up in products with long lives, such as machinery, equipment, buildings, and communications. These goods are sensitive to variations in economic activity, and are adversely affected during a downturn in economic conditions. This is a short-run phenomena.

Metal consumption in industrialized countries is growing slowly because construction work and investment in capital machinery and equipment has decelerated since the attention is now directed towards service projects. Service projects do not use a lot of metal (Tilton, 1983).

Getting back to the argument of the impact of prices on production during the post-1976 era, in spite of the seemingly gloomy picture, the outlook for copper prices is promising because of the following factors:


First, copper has inherent attributes like high thermal and electrical conductivity, corrosion resistance, and high tensile strength that cannot be fully replaced by the competitors. Second, the demand for copper is expected to increase because of population growth and rising industrialization of developing countries. Third, the excess capacity that existed in the industry has virtually been eliminated. Fourth, the world economic growth rate is improving (Mining Journal, various issues).

It is no wonder that the price of copper went up in 1987 and 1988. The improved profit margins of the Zambian mines will result in higher output because more capital is available for investing in existing capacity and capacity expansion.

3.2 Transportation

One of the major potential determinants of Zambia's mining industry's poor output performance is the transportation system. Transportation can influence production because of high costs and unavailability of services. While transportation costs will reduce production because of the resultant high marginal costs, the physical availability of transportation will restrict production because production will adjust to the level of transportation availability.

Zambia is a landlocked country bordered by Malawi on the east, Angola on the west, Zaire and Tanzania on the north, and Mozambique, Zimbabwe, Botswana and Namibia on the south (see Figure 1.1.). The outlets to sea constitute the route to Lobito Bay on the western coast, to Beira or Lourenco Marquis in Mozambique or East London and Port Elizabeth in the south. Apart from the outlet to Lobito, the remaining routes pass through Zimbabwe. All these routes traverse at least 1,500 miles of track before the sea is reached (Figure 3.1.).



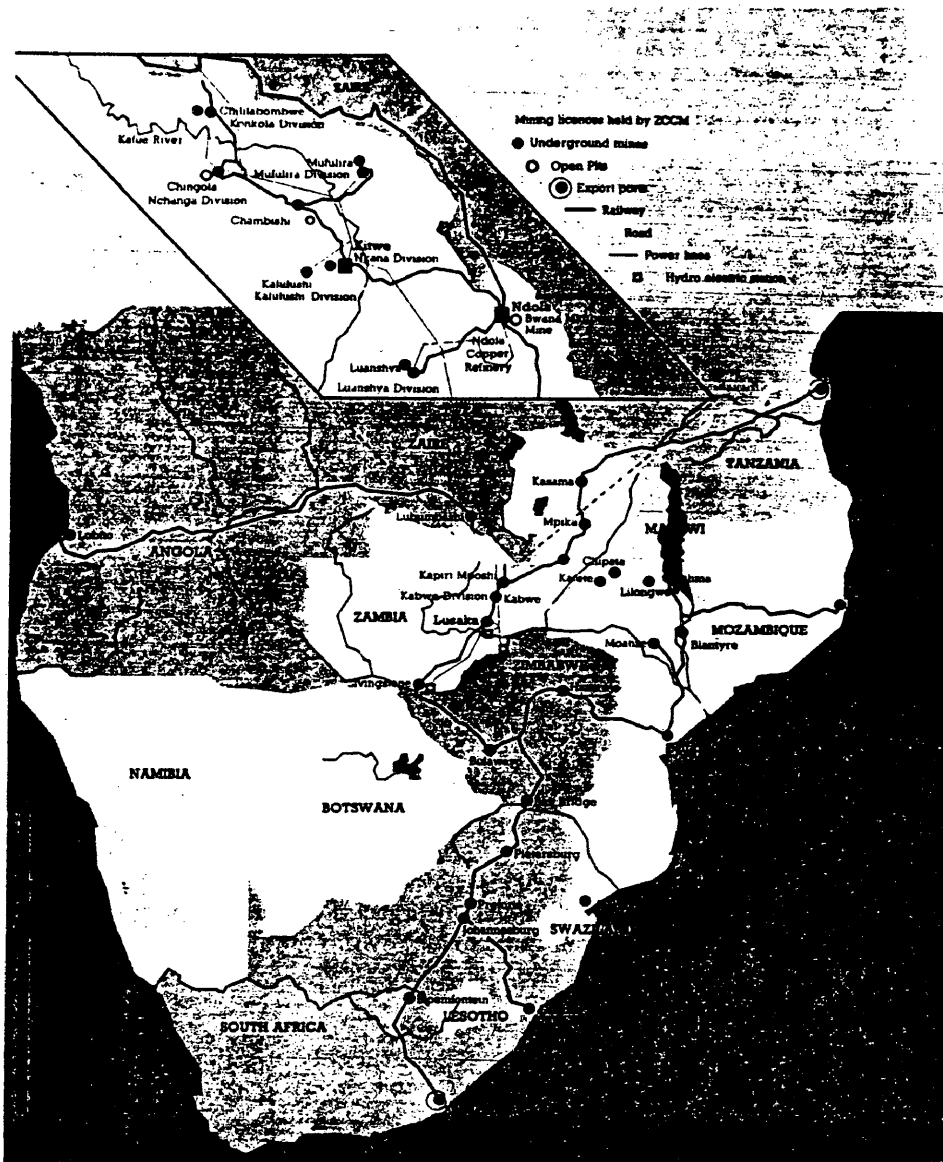


Figure 3.1. Zambia's Transportation Routes
Source: ZCCM Annual Report, 1984.

Transporting over such overland distance is an immense task in itself. This task has, however, been magnified by political instability in the neighboring countries and the events in Southern Africa: the Unilateral Declaration of Independence (UDI) from Britain by Zimbabwe, the political unrest in Angola, and the racial policies of the Southern African government. It is likely that the transportation costs may have been increasing while the physical availability of transport may have been decreasing during the post-1976 period because of the bottlenecks in transportation culminating in the movement of the supply curve to the left and caused a slump in production (Europa, 1987 and Cunningham, 1981).

As shown in Table 3.2. and Figure 3.2., the transportation costs per tonne of copper have been volatile especially during the pre-1976 era. The volatility is mainly attributable to instability of transportation routes precipitated by the political instability in neighboring countries.

The political difficulties which led to transportation difficulties date back to 1965 with the disruption of the major international transport routes by the closure of the Zimbabwean border after a Unilateral Declaration of Independence (UDI) from Britain by Rhodesia, now Zimbabwe.

Table 3.2. Real Transportation Costs

<u>Year</u>	<u>Cost</u> (Kwacha per tonne of copper)
1965	127
1966	141
1967	158
1968	156
1969	152
1970	131
1971	146
1972	149
1973	125
1974	131
1975	168
1976	144
1977	134
1978	134
1979	122
1980	139

Source: Zambia Mining Year Book. 1978 and 1980.

1980=100. Zambian GNP deflators used.

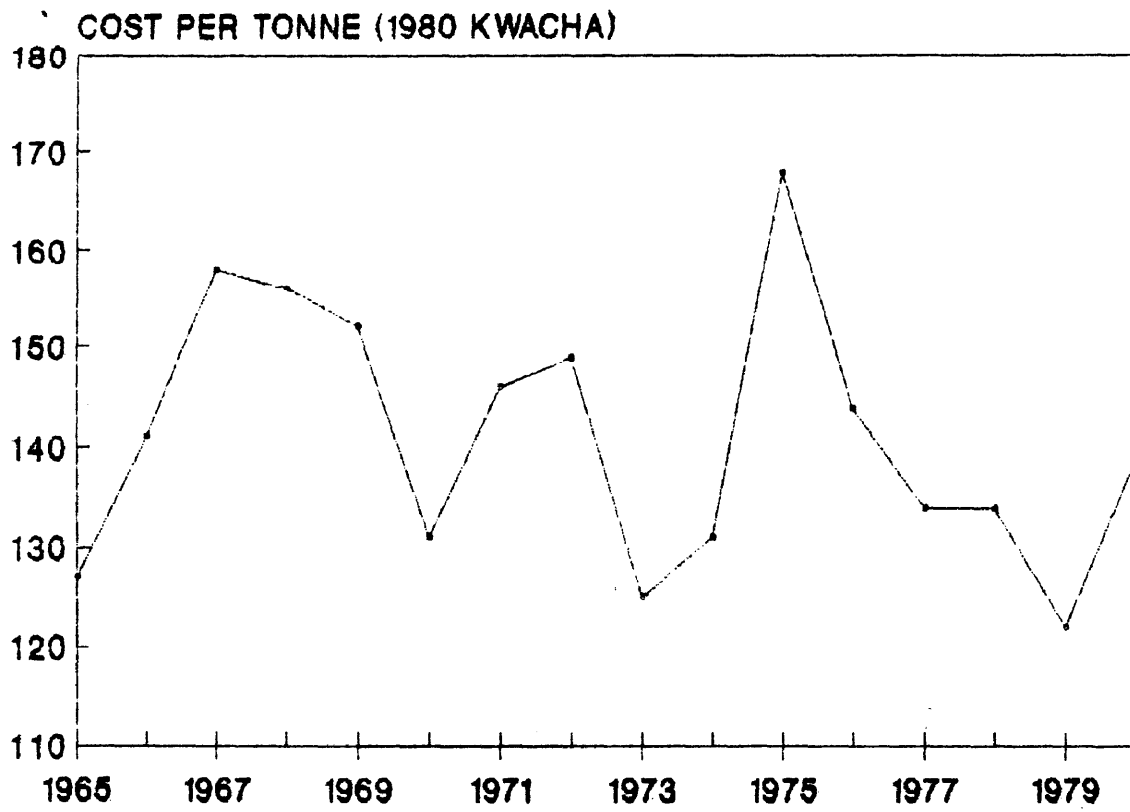


Figure 3.2 Zambian Real Transportation costs

Source: Table 3.2.

The closure of the Zambia-Zimbabwe border halted all copper shipments and trade through the southern route. During the period when the border was closed, Zambia's exports and imports were trucked overland to and from the Tanzanian port of Dar-es-salaam or Mombasa in Kenya through the partially tarred Great North Road which later earned the name "Hell Run" because it quickly became almost impassable owing to the unaccustomed stress placed on it by the heavily loaded trucks. This roadway was substandard and inadequate to handle all the Zambian traffic. The shipments were reduced to two-thirds of the normal load (ZCCM Annual Reports, various issues and Africa, 1988).

In an attempt to ease a desperate situation in both exporting copper and maintaining a steady flow of essential commodities, principally petroleum products, equipment, and machinery, the mining industry in 1966 created history in the copper market when it started airlifting copper with Hercules transport planes. The copper airlift was not a profitable venture, but it made a substantial contribution to Zambia's trade at a time of national emergency although high costs were incurred in the process.

Meanwhile alternative transportation routes to the coast were being developed to avert further interference with the flow of Zambian copper to the world market while

airlifting of the cargo continued until the rationalization of copper export routes was finally completed in 1968. Almost all of the Zambian copper was transported through Beira, the Great North Road to Dar-es-salaam, and to Lobito Bay. These efforts paid dividends through reduced transportation costs.

In 1969 the transportation routes were still stable and an increase in shipments via Tanzania-Zambia road (Great North Road on Zambian side) from a monthly average of 17,000 tonnes to 23,000 tonnes was achieved during the year.

In the Zambian government's effort to strengthen the stability in transportation routes, a decision was made to develop the Zambia Tanzania Railway Authority (TAZARA), a rail road to link Zambia with the port of Dar-es-salaam in Tanzania on the east coast of the African continent with the help of the Chinese who undertook the task of constructing the railway line. The venture was a product of a bilateral trade agreement between Zambia and Tanzania. Construction began in 1970.

In 1971, transportation costs went up because of problems with the Tanzania-Zambia road. Most of the road was washed away by heavy rains resulting in restricted production from the Zambian mines. This problem continued into 1972.

Political factors surfaced again in 1973 when the border between Zambia and Rhodesia was again closed. Rail shipments through Zaire and Angola via Bengwela railway to Lobito bay were increased to 55 percent of exports to cater to the extra shipments from the affected route through Beira. The remainder was trucked to Dar-es-salaam in Tanzania or Mombasa in Kenya. However, since the border closure happened towards the end of the year, the impact was not immediately felt and the transportation costs were relatively low (USBM, 1971).

In 1974, civil unrest in the newly independent Angola occasionally disrupted traffic on the route to the Angolan port of Lobito Bay which had become an important link between Zambia and the sea. The combined effect of the border closure and occasional disruption of the Bengwela route created a bottleneck which led to high transportation costs. Production did not fall immediately.

The bottleneck became more critical in 1975 when Zambia was forced to abandon the Lobito Bay route when the civil war escalated in Angola and halted all traffic on the Bengwela railway line. A substantial amount of Zambian copper was impounded or lost. About 800 railway cars were marooned and had to be reconsigned to Indian Ocean ports at considerable cost. The increased costs and disruption in

the transportation route that carried over half of the Zambian output caused a drop in production in 1975.

Fortunately, TAZARA, the 1,116 mile long railroad (Europa 1987), which had been completed in 1975, two years ahead of schedule, immediately became operational and made a very important contribution to the mining industry's transportation system. The period after 1976 generally experienced low transportation costs.

Nevertheless, long turnaround times, a result of problems with the TAZARA, and poor port facilities at Dar-es-salaam severely reduced the physical availability of transportation services in turn affecting production.

The Chinese supplied DFH2 diesel hydraulic locomotive proved inadequate partly due to low power and partly due to the fact that the railway line was constantly in a state of disrepair causing the average turnaround time on the TAZARA to rise from 11.7 days in 1975-1976 to 26.1 days in 1981-1982. Efficiency at the port was constrained by shortages of handling equipment.

The long turnaround time and poor port facilities severely constrained the transportation capacity of the TAZARA. In 1980, for instance, TAZARA transported a mere 30 percent of the total Zambian traffic which consisted mainly of copper exports while the rest was diverted to the longer

southern route through Rhodesia (Africa, 1988) which became operational in 1978 after the reopening of the border between Zambia and Rhodesia (now Zimbabwe). The increasing inefficiency of the TAZARA resulted in high costs in 1980, though production increased marginally.

Transportation bottlenecks were therefore responsible for the fall in production in the years after 1976. Though transportation costs show a declining trend, the physical availability of transportation services was low. Because of low availability of transportation services, the mines have been forced to curtail production to avoid high inventory costs.

Zambia cannot do much about its geographical location, but projects aimed at reducing costs to improve profitability by improving the efficiency of transportation can be initiated. This is exactly what Zambia is trying to do. Currently, the TAZARA network is undergoing a ten-year rehabilitation program. The required amount is about K 2 billion, and already K 1 billion has been obtained through loans from the United States Agency for International Development, the World Bank, and other lending institutions (Africa, 1988).

Evidently, the rehabilitation exercise is already paying dividends. The new wagons and locomotives obtained as

part of the rehabilitation exercise, coupled with a major management overhaul, has reduced the turnaround time to 12 to 15 days causing the traffic handled to shoot up from 984,000 tonnes in 1985-1986 to 1.2 million tons in 1986-1987, representing 80 percent of Zambia's exports and 45 percent of imports. A capacity of 1.5 million tons of cargo per year is expected to be attained by 1990. In addition, the road previously dubbed the "Hell Run" is being resurfaced to allow for more capacity availability. Plans are also under way to improve the port facilities (Africa, 1988).

In spite of the transportation difficulties, the future for the industry is promising given the recent rehabilitation program aimed at revamping the TAZARA. When the exercise is over, reduced transportation costs are expected. These will translate into improved production to the company.

Chapter 4

POLITICAL FACTORS

The decline in Zambian copper output may have been caused by political factors, mainly the takeover of the mining concerns by the government. Before analyzing the importance of these factors, an account of the events that led to nationalization is outlined below.

The Zambian government took over the majority ownership and control of the two mining companies, Roan Selection Trust (RST) and Anglo American Corporation (AAC), in 1970 when the Zambia Industrial Mining Corporation (ZIMCO) was established. It acquired 51 percent of the mining industry's equity (Kaunda, 1968 and 1969). The details of the proposed purchase of a majority shareholding in the industry were successfully finalized on October 18, 1969. The mining companies got Zambian bonds issued by ZIMCO at 6 percent for their stock, payable in installments through 1978 for RST and 1982 for AAC for a total acquisition cost of K 210 million. The mining companies were consolidated into two operating companies: Nchanga Consolidated Copper Mines (NCCM) and Roan Consolidated Mines (RCM). The former AAC holdings formed NCCM, while RST properties became RCM (Nziramasa and Obidegwu, 1981).

The former owners maintained control over operations. AAC and RST obtained substantial management contracts to operate the industry with the remuneration based on the gross value of the output, profitability and the number of expatriate workers recruited from abroad to fill the positions of those who had left the mines. All restrictions on dividend repatriation were removed.

But this deal was seen as being too good to last long and the mines continued repatriating as much as they could. With the relatively high copper prices in 1973, the minority shareholders generated substantial revenue from the management contracts and repatriated a very large part of whatever profits were made. This caused dissatisfaction among government officials who had expected them (shareholders) to reinvest most of the profits, forcing a premature redemption of the bonds in the same year. The management contracts with the mining companies were terminated in 1974 and 1975 for AAC and RST for a lump sum of K 50 million as compensation for loss of management, technical, and marketing contracts. Both companies became self-managing under Zambian managing directors appointed by the government (Nziramasa and Obidegwu, 1981).

The subsequent merger of these companies in 1982 to form Zambia Consolidated Copper Mines (ZCCM) was the final

stage in the reorganization of the nation's mining industry. It left 60.3 percent of ZCCM's equity held by ZIMCO with the remainder being held by RST International Inc. (Mining Journal, various issues).

The acquisition of the mineral concerns by the government was motivated as indicated earlier by the continuous disinvestment by the mining industry. The owners were reluctant to plow back profits into expansion projects, and all expansion plans were either curtailed or abandoned altogether. Almost all the profits were repatriated. Government involvement was therefore necessary to make the industry more responsive to the needs of the country. Examples of the projects which were on paper but were either partially realized or never materialized are discussed below.

According to the five-year plan effective in 1967, the AAC group scheduled an expenditure of K 133 million, K 28 million on Bancroft mines (Konkola), K 54 million at Nchanga, K 25 million at Rokana (Nkana) and the balance on the reopening of Bwana Mkubwa mine with development costs of K 10 million, and development projects at Mindola and Kansanshi (ZCCM Annual Reports and Zambia Mining Year Book, various issues).

At that time, an oxygen plant was under construction at Nkana to boost the smelter efficiency at a cost of K 4 million. In addition, extensions to the smelter including an extra anode casting plant, all of them worth K 1.2 million were being installed.

The RST group had their own schedule during the same period. The plan encompassed an expansion of Mufulira mine by 25,000 tonnes of copper annually to a total yearly production of 187,000 tonnes, and an increase in smelter capacity by more than 50,000 tonnes to 226,000 a year. Costs were estimated at K 9 million and K 5.8 million respectively. At Luanshya, the smelter capacity was to be expanded and new installations were to include a converter, a roaster plant, and an acid plant. Baluba mine was simply awaiting a technical report to be on line (Zambia Mining Year Book, various issues).

After two years, only very few of the projects were in progress. Both the AAC and the RST groups just continued with projects which were in progress during the plan period. Only the Bwana Mkubwa and Baluba projects and part of the Luanshya project materialized. The rest were shelved on account of insufficient funds. However, an examination of the payout rates for both companies yield interesting results. From Table 4.1., the average payout rates turn out to be 80

Table 4.1. Mining Industry Dividends

<u>Year</u>	<u>Mufulira</u> (Kwacha per share)	<u>RST</u> (% of net income)
1965	0.895	63
1966	0.935	71
1967	0.949	71
1968	1.210	76
1969	1.350	55*

Source: Zambia Mining Year Book. 1969.

* Split on shares issued on capital in May 1969.

percent of the net income for the AAC group while those of RST group increased from K .895 to K 1.350 per share during the period under consideration.

The government was angered by this lack of appropriate response by the mines to the country's economic well being, prompting the measures which placed the major ownership and control in the hands of the government. To avoid the start-up costs, Zambia awarded management, technical, and marketing contracts to the minority share-holders. These, as noted above, were later terminated ahead of time because the mines continued to exercise the divesting policy.

Yet another reason for the majority ownership and control was the role of the mining industry in the country's economy. The mining industry is the only significant source of foreign exchange in Zambia, and its continued ownership and control by foreigners was not in line with political and economic independence (Radetzki, 1985).

The question at hand then is the extent to which political factors have affected production since 1976. In answering this question, labor productivity and relationships, and investment patterns will be analyzed.

4.1 Labor

Labor plays an important role in the performance of the mining industry. The mining industry consists of complex operations that demand a high degree of technical know-how and competence in management and operations. For instance, a maintenance schedule which looks relatively easy to draw and follow needs careful planning and implementation. If the routine is not properly followed, disastrous results will follow and low outputs will prevail.

Low output can result if critical repair work is not done on time on the mistaken assumption that the problem is minor. In this way, a major disruption in the production process may occur. The disruption will effectively increase the unit costs leading to low production levels because the supply curve will move to the left.

To make up a relatively flawless schedule requires good insight of the operations. And this insight can only be gained through experience. In the meantime production is expected to decline because of the learning costs leading to lower labor productivity figures. It is theorized that when the government assumed majority ownership and control of the mining industry, a relatively new and inexperienced team took over the management function. Labor productivity may have dropped because of learning costs which caused a decline in

production.

It is worth mentioning that productivity is not a good measure of labor performance in that implicit in the measure is the assumption that only the labor performance is changing while the other variables remain constant. Among the variables assumed constant are the efficiency of operating machinery and equipment, and ore grades. Strikes and other forms of disruption to production are regarded as nonexistent.

Indeed there was a decline in labor productivity as exhibited in Table 4.2. Labor productivity dropped from 15 tonnes of copper per man year in 1965 to 8 in 1986. However, it is difficult to peg the timings of the decline in productivity to the fall in production because the information available is scanty.

On the basis of the available information, it can be deduced that the decline in productivity may have been responsible for the fall in production. But the fall in productivity was not necessarily a result of the assumption of majority ownership and control of the mines by the Zambian government because when Zambia nationalized the mines, the minority shareholders were awarded management contracts. These contracts were discontinued in 1974 and 1975 for AAC and RST. Therefore, one would expect a drop in productivity

Table 4.2. Labor Productivity

<u>Year</u>	<u>Productivity</u> (tonnes per manyear)
1965	14.9
1968	14.2
1970	14.0
1975	11.7
1977	11.1
1979	10.5
1980	10.3
1984	9.2
1986	8.3

Source: ZCCM Annual Report, various issues.

to occur probably in a year or two after the redemption of the contracts, taking into consideration the lag in the effect of poor management.

The decline in productivity, on the other hand, persisted throughout the period under review. The reduction in productivity was caused by a host of factors apart from the learning costs. The drop is explained as follows.

First, the decline in ore grades entailed treating higher volumes of ores to extract the same amount of metal that was extracted previously. For instance, in 1969, 43 tonnes of ore were treated per tonne of finished copper; this rose to 52 in 1981 (Radetzki, 1985).

Second, the mining company upon nationalization took over the responsibility of many services which previously were being performed by contractors (ZCCM Annual Report, 1984). Invariably, the labor force increased without a corresponding increase in production because the extra labor from services was not directly involved in the production process.

Third, the decline in the quality of supervision and management because of low experience largely by expatriate personnel and the high labor turnover that disrupted continuity led to a sharp fall in maintenance and operational standards which in turn, led to low production. The high

turnover of experienced labor was caused by the political independence of Zambia and later by the nationalization of the mining industry as shown in the ensuing discussion.

Immediately after independence on October 24, 1964, the employment status of foreign mineworkers was changed to that of expatriates. Fixed period contracts were introduced for expatriates whose job-life expectancy was more than two years and who until then, had been on continuous contract employment. Those who fell outside this category had their positions filled with Zambian nationals (Zambia Mining Year Book, 1966).

This, coupled with the political uncertainty created by the fast-spreading wave of nationalization of mineral industries in newly independent states, led to high labor turnover rates and difficulties in recruiting skilled personnel, starving the industry of the required expertise.

The situation deteriorated even further because the Afrikaners, descendants of the Dutch colonizers who at that time worked for the AAC mining company, refused to live under Black rule and left for South Africa. These workers were largely replaced by expatriates of British descent, the former colonial masters of Zambia (Martin, 1972).

After nationalization, the expatriate turnover was motivated by the uncompetitive remuneration and the

Table 4.3. ZCCM Labor Strength

<u>Year</u>	<u>Local</u>	<u>Expatriates</u>	<u>Total</u>
1965	39,680	7,040	46,720
1970	44,090	4,380	48,470
1975	52,990	4,500	57,490
1980	55,260	2,490	57,750
1982	54,230	2,050	56,280
1986	54,390	1,450	55,840

Source: Adapted from Radetzki. State Mineral Enterprises.
1986. Figures for 1986 obtained from ZCCM Annual Report.

insecurity brought about by the termination of the management contracts in 1975. As shown in Table 4.3., the expatriate manpower dropped by 36 percent from 1965 to 1975. A drop of 68 percent was experienced between 1975 and 1986.

The quick reduction in expatriate labor that occurred between 1975 and 1986 started to affect production adversely because the standard of equipment maintenance deteriorated considerably, resulting in high operational costs per unit output. Consequently the supply curve shifted to the left and a decline in production was experienced. However, it is worth noting that the low labor productivity between 1965 and 1975 was a result of declining ore and high labor turnover. But after 1975, in addition to the factors outlined earlier, learning costs contributed to the fall in productivity and hence production because a large number of skilled manpower was replaced by a relatively inexperienced labor force.

Though it is very difficult to quantify the length of time that learning costs last, it is the author's opinion that the labor problems which are clearly within the control of both the mining company and the Zambian government are not expected to impact production negatively for a long time in view of the rigorous training program that the company has embarked on.

4.2 Labor Withdrawals

Another theory of the effect of nationalization is the poisoning of state labor relations. Nationalization supposedly promises higher wages, better benefits, and access to skilled and administrative positions. In most cases these promises are never fulfilled to the expectations of the labor force. Eventually, a seed of discontentment is sown in the labor force because it feels betrayed; usually the grievances are aired through withdrawal of labor.

Strikes disrupt production and directly affect the amount of copper that can be produced. It is thought that stoppages of work may have played a prominent role in the declining output from Zambian mines

Prior to 1976, only two strikes are on record, both in 1966. The strikes were caused by bad working conditions and the introduction of Zambia National Profident Fund, a pension scheme. However, strikes have become common since 1976.

In 1981, a strike grievance was the dual salary structure between local employees and expatriate personnel. The strike lasted two weeks. Following the strike, a new collective agreement was signed covering a two-year period from November to follow the abrogation of the 1979 wage agreement. The agreement covered inter alia, new pay scales, leave entitlements, etc. The strike contributed to lower

production during the year.

Yet another strike occurred in 1985 over the pension scheme and general benefits accruing to the scheme. A new collective agreement was signed between the mine workers union and the mining company to improve the conditions of service for all employees. This time the strike lasted for slightly longer than a week. But the impact on production was quite significant. Because of the strike, production went down in 1985.

Indeed, strikes have adversely affected production. In essence, the supply curve shifts to the left resulting in low production. Strikes were responsible for lower production in 1981 and 1985. The strikes, however, were not a result of promises to the workers prior to nationalization not being fulfilled by the government, as theorized earlier, but were dictated by a host of different events. In fact, none of the promises implied earlier were made by the government.

It can be argued that strikes, though they cause disruptions to production, are only temporary setbacks. Production should therefore be low in the affected years. The decline in production since 1976 cannot wholly be explained by strikes.

Stoppages of work are within the control of the Zambian government and the mining company. The strikes discussed

above could have been averted if the company and the government had acted in a timely fashion. Most of the changes to the workers' demands were made after strikes. There is need to improve communications between the labor leaders and the company to settle grievances amicably. In this way, production loss due to labor withdrawals will probably be eliminated.

4.3 Investments

Investments are an integral part of the mining operations. It is necessary that capital goods used up during the production process be replaced if current production levels are to be maintained or increased. To increase output, the yearly capital expenditure must exceed the capital needed to keep the capital stock intact. A depletion of capital stock will translate into a decline in production because unit costs will steadily increase through high maintenance costs and machine inefficiency, shifting the supply curve to the left. A decline in production then prevails.

State-owned mining companies in developing nations tend to have a diversity of development objectives such as providing employment and maximizing revenue. Therefore, the funds that are supposed to be plowed back into the operations

Table 4.4. ZCCM Real Capital Expenditure

<u>Year</u>	<u>Investment</u> (million kwacha)
1965	116
1966	97
1967	84
1968	40
1969	76
1970	104
1971	170
1972	174
1973	175
1974	169
1975	202
1976	176
1977	123
1978	132
1979	84
1980	88
1981	164
1982	78
1983	110
1984	61
1985	70

Source: ZCCM Financial Analysis Department.

1980=100. Zambian GNP deflator used.

are channeled to other projects. Consequently, production from the mining sector declines in the long run.

From Table 4.4., it can be seen that the period prior to 1976 was a period of relatively high investments. Thereafter, investments declined, causing a reduction in production. During the period 1971 to 1975, investments averaged K 178 million per year and were sufficient to maintain production. Over the period 1976 to 1980, investments dropped to K 120 million, a reduction of 32 percent, causing many operational difficulties. Equipment and machinery could not be replaced, and shortages of spare parts and other consumables were rife. In many cases, the company was forced to settle for crude spare parts refurbished within the plants. The extent of these problems and their impact on production is discussed below.

In 1978, Nchanga Division, one of the major operating divisions of the mining company was forced to put the open pit operations off stream for about three months because a shortage of lubricants grounded earth moving equipment. Overburden stripping fell behind schedule. The author estimates 12,000 tonnes as the fall in mine production, accounting for 4 percent of Zambian mine production. Consequently, production from this mine as well as total Zambian output was poor. Even in more recent times, the

constant shortages of spare parts and operational accessories has continued to affect operations.

The problem of lack of critical items is present throughout all ZCCM divisions. In 1984, for instance, development and drilling operations at Baluba, Chambishi, and Luanshya mines fell behind schedule owing to poor availability of loaders and drilling equipment, resulting from lack of essential spare parts and explosives accessories.

In 1985, the problem became even more pronounced at Chibuluma, Chambishi, Konkola, and Mufulira mines where both development and production performances failed to meet expectations because of erratic availability of loaders and rock drilling equipment, and overuse of old equipment. Mine production dropped by 2,000 tonnes, 7 percent of the the Zambian mine output. Accordingly, total copper production declined.

The level of investments contributed to the fall in Zambian copper production during the period 1976 to 1986. However, contrary to popular belief, the investments were not low because funds were reallocated to other projects. The depressed capital expenditure between 1976 and 1986 was a result of prolonged periods of low copper prices and the fact that the Zambian government was at this time making

significant compensation payments for its share of the mining company through dividends (Nziramasa and Obidegwu, 1981) from the mines which at this time were quite low. The government had to borrow extensively (Table 4.5.) to makeup for the difference.

Depressed prices, rising production costs and natural disasters are no strangers to the mining industry. The Zambian government should have incorporated a safety clause in the compensation payment agreement allowing for a delay or deceleration in payment in years of little or no profits, and accelerated payment when profits were high. Instead, it worked on the assumption that profits would exceed compensation payments (Martin, 1972).

External circumstances dictated the level of investments that could be injected in the mining operations. Consequently, production after 1976 suffered because of low investments. With the current high prices and improved transportation efficiency, investment levels are likely to increase and the operations will be revitalized.

4.4 Taxation Policies

The study of the Zambian mineral tax regimes and their impact on production are discussed below. Three types of taxes have been applied to the Zambian industry: royalties,

Table 4.5. Zambia's External Debt

<u>Year</u>	<u>Debt</u>	<u>Service Payment</u>	<u>% of Exports</u>
	(million kwacha)	(million kwacha)	
1965	154.6	-	-
1969	246.6	26.9	2.2
1970	547.9	54.4	5.7
1971	532.2	71.8	10.3
1972	571.7	85.3	10.5
1973	1221.9*	709.1	60.1
1974	762.2	105.6	7.3
1975	1098.8	88.5	10.2
1976	1251.1	112.7	10.2
1977	1391.7	181.0	18.7
1978	1396.3	191.4	20.8
1979	1558.6	300.6	-

Source: World Bank Debt Tables. 1987.

* Unusually high because of a premature redemption of bonds for compensational payments to the mines.

export, and income taxes.

The royalty tax is production-based and does not take into consideration the ore grade or quality. This tax has an effect analogous to a rise in costs of production causing the investor to demand a higher expected rate of return. Consequently, certain investments that could otherwise have been implemented are rendered submarginal. The royalty tax also helps deplete mineral reserves much faster.

From microeconomics, it is known that a producer maximizes his profit by equating his marginal revenue with the marginal costs. In the presence of royalties, the producer will equate his marginal revenue to the marginal costs plus royalty costs, leading to a drop in production if the marginal revenues remain constant. In this situation, the producer will choose to exploit higher grade ores to reduce on costs directly changing the cutoff grade.

Another disadvantage of this taxation regime is the fact that low cost mines have light tax liabilities while high cost mines have heavy tax burdens. This tends to make less profitable mines poorer, sometimes forcing them into closure.

The export tax is somewhat similar to the royalty tax. It represents a charge on production and may weaken the competitive position of the mines because it, too, like the royalty tax, increases the production costs thereby reducing

the maximum production costs that the company can support.

The income tax on the other hand is based on the residual between revenues and costs. Therefore, it affects production in the sense that the capital available to the company is reduced because of the income tax charge. Income tax also discourages exploration in that the expected payoff from discovering a new deposit declines with the level of tax.

This chapter focuses on the changes in the tax regimes to determine whether the movements in taxation have been such that production has been affected over time, focusing specifically on the period before and after 1976.

In 1965, the Zambian government announced its intention to retain the formula with a minor adjustment, for assessing the copper royalties that the British South African Company had been applying. The amount of royalty was now determined in reference to the average prices of copper on the London Metal Exchange rather than on producer selling prices. The royalty tax was levied on every tonne of finished copper exported at a rate of 13.5 percent of the average London Metal Exchange (LME) price per tonne during the month of production, less K 16.00. The export tax, introduced later in 1966, was charged on every tonne exported at 40 percent of the amount, if any, by which the average LME price exceeded

K 600.00. The income tax was pegged at 45 percent of the profits.

In 1969, a new mineral tax regime based on profits was introduced. Under this method, royalties and copper export taxes were replaced by a mineral tax amounting to 51 percent of the profits. A 45 percent income tax was charged on the remaining profits after deducting the mineral tax. This tax system allowed losses to be carried forward from bad years and applied against profits in the good years. This tax regime was an improvement over the previous tax system. The anomalies were removed. Less profitable mines no longer paid higher effective tax rates than the profitable ones. And taxes could now not exceed profits because unprofitable mines were not taxed.

In April 1983, a mineral export tax was reintroduced levied at 4 percent of the gross amount received from sales of copper during the year. This levy was not deductible in computing income or mineral taxes. The mineral and income tax rates remained unchanged. The mineral export tax was later increased to 8 percent, 10 percent and 13 percent in August 1983, January, and October 1985. Later in 1986, the rate was reduced to 11 percent.

In 1988, the government scrapped the mineral export and royalty taxes and the company is now responsible for income

tax liability only.

Except for the tax regime between 1966 and 1969, which could have had a negative impact on production, the taxation regime between 1969 to 1976 was very favorable. The same tax system was applied to the period between 1976 and 1983. However, after 1983, the reintroduction of the mineral export tax had a profit creaming off effect. The company was deprived of all the profits. The decline in production between 1976 and 1983 was not due to taxation because during this period taxation was quite favorable. The tax regime had an effect on production during 1983 through 1986. In fact the company was taxed even though no profits were made (see Table 4.6.).

The mining industry is not in a position to influence taxation. Taxation is the sole responsibility of the government. However, with the recent announcement of the tax holiday granted to the mines by the government, an improvement in production is expected.

Table 4.6. Mineral Taxation and Profits

<u>Year</u>	<u>Pre-tax Profit</u> (million kwacha)	<u>After-tax Profit</u> (million kwacha)
1983	-123.0	-127.5
1984	96.9	1.0
1985	145.0	1.0
1986	300.0	-56.0
1987	211.0	-562.0

Source: ZCCM Annual Reports

Chapter 5
CONCLUSIONS

Zambian copper production fell substantially between 1976 and 1986, from 709,000 tonnes to 463,000 tonnes. Several factors were responsible for this decline, including declining ore quality, mine accidents, strikes, transportation bottlenecks, insufficient investments in the mining operations, prolonged periods of depressed copper prices and political factors.

Among the above, the most important are transportation bottlenecks, insufficient maintenance and investments in operations, and political factors. These factors affected production throughout the period under review. The less important factors are those that affected production intermittently, including strikes, and mine accidents.

The literature on the Zambian mining industry (Radetzki, 1985) identifies the nationalization of the mining industry as an important cause of the lower output and higher costs for a variety of reasons. First, start-up and learning costs were incurred after nationalization causing production and capacity utilization to fall. Second, mineral production costs continued to rise because the government had used the mining industry to promote social goals, resulting

in significant costs. Third, production is inelastic to prices because the labor component of the variable costs is considered a fixed cost.

Indeed, the conclusions from the variables that were investigated seem to lend support to the above conclusions. Though the takeover did not immediately affect labor productivity, the termination of the management contracts affected the mining industry adversely. The industry started relying on less experienced personnel. The industry suffered from infancy. Meanwhile costs went up while labor productivity declined.

In addition, the foreign exchange allocated to the mining industry by the government has been insufficient to meet the needs of the mining operations. The meager foreign exchange available to the government primarily, earned by the mines, is also used for other objectives. Consequently, the industry is plagued with shortages of spare parts and other consumables which have in turn have affected production.

Among the diverse objectives of the mining industry is providing employment. Therefore, even though some mines have closed, the labor force from these mines has been redeployed to operational mines. In this sense then, labor is a fixed cost. Hence, the supply curve is inelastic to price changes in the short-run; even though copper prices have improved for

the past two years, production has not improved.

Production between 1976 and 1986 was affected by a host of factors. More specifically, the poor output between 1977 and 1979 was a direct result of declining ore quality, closure of Chibuluma open pit in 1978 on account of exhaustion of reserves, mine flooding at Nchanga during 1977, low investments, poor copper prices, and instability in transportation routes in 1975 and 1977 and poor availability of transportation services.

The output performance in 1981 was restrained by the poor quality of ore, closure of Mimbula and Fitula mines, low investments, a miners' strike, and low labor productivity. For the period between 1983 and 1984, low ore grades, depressed copper prices, low labor productivity, poor investments, and unfavorable taxes were responsible for the fall in production.

Finally, between 1984 and 1986, production was affected by a strike in 1985, low investments, unfavorable taxes, poor labor productivity, and dampened prices.

Because of the problems that the mining industry has gone through, one would expect the outlook for the industry to be very bleak considering declining ore quality and reserves, heavy taxes, low investments, foreign exchange, and labor problems. On the contrary, the future is very

promising. Apart from the declining ore quality which is a major concern, the other factors are of less concern. The transportation system is being rehabilitated, the Zambian government has granted the mines a tax break, low investment problems will be solved easily given the improved profit margins from improved copper prices, and the labor problems are not expected to continue because the company has formulated a rigorous training program. These factors project a prosperous image for the Zambian copper industry. Production is expected to rise as soon as the adjustment process is over.

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APPENDIX
ZAMBIAN EXCHANGE RATES

<u>Year</u>	<u>Exchange Rate</u> (dollar per kwacha)
1965	1.40
1966	1.40
1967	1.40
1968	1.40
1969	1.40
1970	1.40
1971	1.40
1972	1.40
1973	1.53
1974	1.54
1975	1.54
1976	1.40
1977	1.27
1978	1.25
1979	1.26
1980	1.26
1981	1.15
1982	1.08
1983	0.80
1984	0.56
1985	0.37
1986	0.14
1987	0.11

Source: International Monetary Fund, International
Financial Statistics. 1988.