Chapter 3

# The Business Structure of the Copper Industry

# CONTENTS



## Boxes



## Figures



## Tables

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# The Business Structure of the Copper Industry

The structure of the world copper industry has changed significantly during the last 25 years. Rapid growth in world copper demand began in the industrialized countries following World War II, and then shifted to the less developed countries. This led to the construction of significant new copper production capacity, Initially this capacity was owned and operated by the same corporations that had controlled the industry for most of this century. Gradually, however, changes in investment risks, in the development philosophies of third world countries, in the diversification strategies of multinational corporations, and in the way copper is bought and sold on world markets, changed the picture substantially. Today, instead of several multinationals developing copper properties and selling their products under contract prices, there are numerous producers–many of them government-owned or controlled. In addition, since the mid- to late 1970s, the New York and London commodity exchanges have played a more important role in setting copper prices.

This chapter reviews the major factors that have influenced the structure of the world copper industry in recent years. It begins with a discussion of the investment risks in a copper venture. It then outlines trends in domestic and world copper capacity ownership since 1960, and analyzes the role of international financial institutions in capacity development. The chapter ends with a description of pricing, including how prices are set, the factors that may affect price over the short- and long-term, and the impacts of unstable prices on producers. The following chapter describes the market structure of the copper industry in terms of supply and demand trends.

## INVESTMENT RISK

**Copper mining and processing are characterized by large, high risk capital investments.** Because many mining operations are located in remote areas, significant infrastructure costs often are incurred as well. Thus, private investors in the mining industry require a greater return on invested capital than those investing in retail or manufacturing ventures of comparable size.

**The potential risks include negative exploration results, market changes during or after mine development, government nationalization, and disruptions from political or natural causes.** First, copper is a relatively scarce element.[1] The size and shape of a deposit must be estimated from numerous data sets with varying degrees of certainty. A company will invest perhaps tens of millions of dollars and 5 years or more in exploration and feasibility studies.[2] Not only must a deposit contain copper, but either the copper or its by- or co-product minerals (e. g., gold, silver, cobalt, molybdenum) need to be of sufficient grade, quantity, etc. that extraction and processing are economically feasible, given current and anticipated conditions in the copper market.

Second, development of a new mine or expansion of existing facilities requires a long leadtime—a year or more for expansions and an average of 2 to 5 years for new operations. During this period, economic conditions can change drastically and may alter profitability. The uncertainty in predicting the economic feasibility of a project increases with the leadtime, and so does the risk.

[1] The Bureau of Mines estimates the average grade of demonstrated lead and zinc resources to be 2.22 and 5.10 percent, respectively, while the average grade of minable world copper resources is less than 1 percent; see ch. 5,

[2] Exploration and developrnent are discussed in detail in ch. 6.

Photo credit: John E. Robison

Copper mining and processing require large, high-risk capital investments.

The political environment of a copper operation also may add risk. Corporate officials can choose a site for a manufacturing plant, but can only mine copper where it is found. More than one-half of the Non-Socialist World's (NSW)[3] copper resources are located in the developing nations of Latin America and Africa. Many of these nations are striving to improve their standard of living through economic development and political autonomy. Strict government control often accompanies this effort and turmoil is not uncommon.

During the 1960s and 1970s, there was a wave of government nationalization of foreign-owned mining enterprises. In some cases, compensation to foreign investors was small or nonexistent. For example, when the Chilean government first expropriated the country's four largest copper mines, compensation was offered for only one mine. Later, when the military junta led by General Pinochet took over the country, some compensation for all properties was negotiated with the previous owners. Because of this risk, private investment in foreign mining operations declined until recently when developing countries, burdened with heavy debts, began offering inducements to foreign investors to bring in needed capital (see discussion of government ownership, below).

Mines and mineral processing facilities located in politically unstable areas (especially those experiencing armed conflicts) have additional risks.

[3]The Non-Socialist World (N SW) refers to all copper producing and consuming market economy countries. This includes Yugoslavia, but excludes Albania, Bulgaria, Czechoslovakia, Cuba, Democratic Republic of Germany, Hungary, Poland, Romania, and the USSR. China is also excluded from consumption and production figures, but is included in trade figures because of the significant amount of copper imported into China from NSW countries in recent years.

These operations sometimes have a strong impact on regional and national economies (i.e., they are major employers or represent significant foreign exchange earnings), making them targets for aggressive actions. Threats of labor shortages, damage to equipment and machinery, disruption of energy supplies, and interruption of transportation services loom in these situations.

Supplies do not actually have to be interrupted to have significant economic impacts on U.S. mineral markets, however. For example, a rebel invasion of Zaire's mining country in 1978 led to fears of a cobalt shortage that stimulated panic buying. Prices soared and domestic users turned to cheaper substitutes and recycling where possible. However, mining and processing facilities were closed only briefly, and cobalt production in Zaire and Zambia actually increased 43 percent in 1978 and 12 percent in 1979.4

Copper resources are often located in remote regions, so adverse physical conditions are not unusual. Extreme weather may interrupt production (e.g., at the Andean mines of Chile and Peru), or the altitude, humidity, or other conditions may require extensive testing and adaptation of machinery and equipment.

In addition to being risky, copper mining operations are capital intensive (see box 3-A). More and more of the world's high grade resources are being depleted, making it necessary to mine and process lower grade ores. Capital investment is a function of the gross ore tonnage handled rather than the net amount of copper processed. The need to handle more ore has led to greater mechanization of operations in order to reduce operating costs. This has increased the initial cash outlay for labor, equipment, and services during the start-up time, as well as the cost of the money used to pay these expenses (i.e., the cost of interest on borrowed funds and/or the opportunity cost of equity funding.)

Mining and smelting also have environmental impacts (see ch. 8). In the United States, considerable capital investment as well as increased operating costs are incurred to meet strict environmental regulations. Even in less developed countries, environmental conditions are becoming more important. In 1986, Chilean smelter workers threatened to disrupt production due to concerns about the health effects of sulfur and arsenic emissions. [5]

Mines in remote areas typically require large investments in infrastructure. In addition to housing, roads, and utilities, community facilities such as schools, hospitals, and recreation centers also must be provided. Government subsidization of infrastructure is sometimes available; otherwise, the mining company must absorb the entire cost. Because the cost is incurred before production begins, this increases capital investment.

**Box 3-A.—The Cost of Greenfields Has Grown Tremendously**

The cost of opening a greenfield (new) mining operation has skyrocketed. In the United States, declining ore grades and rigid environmental regulation have compounded this cost. For example, in 1953, the Silver Bell mine/mill in Arizona opened with an initial capacity of 18,000 tonnes of copper per year at a capital cost of $18 million, or $1,000 per ton of capacity. [1] In comparison, in 1982, the Copper Flat mine in New Mexico required an initial investment of $103 million for 18,000 tonnes per year. This represented $5,720 per ton of capacity—470 percent more than the Silver Bell operation.[2]

One result of the tremendous surge in the cost of greenfield projects has been an increase in the incremental expansion of existing capacity. In the 30 years from 1950 to 1980, when demand was growing rapidly, around 20 new copper mines were opened in the United States, while perhaps five mines expanded production substantially. With slightly lower demand growth, only two or three new conventional mines may open in the United States between 1980 and 2000, while most operating mines plan to expand their conventional mine capacity or add leaching capacity during that period.

[1] Cost figures in box 3-A are innominal U.S. dollars.
[2] Simon Strauss, *Trouble in the Third Kingdom* (London: Mining journal Books Ltd., 1986).

4U.S. Congress, Office of Technology Assessment, *Strategic Materials: Technologies To Reduce U.S. Import Vulnerability* (Washington, DC: U.S. Government Printing Office, OTA-ITE-248) May 1985.

[5] Janice L.W. Jolly and Daniel Edelstein, "Copper, " preprint from 1986 *Bureau of Mines Minerals Yearbook* (Washington, DC: U.S. Department of the Interior, Bureau of Mines, 1987).

# OWNERSHIP OF CAPACITY[6]

**Because of the need for large scale operations and the enormous capital investment required, ownership and control of most of the world's copper mining and processing capacity is held by large multinational corporations and State mining enterprises.** Governments and multinationals are better able to acquire the financing for copper mining ventures and to absorb the risks.

**Prior to the 1960s, multinationals controlled most of the world's copper production capacity.** In 1947, four major private mining firms held an estimated 60 percent of world copper output.[7] This share had dropped to 47 percent in 1956 and, by 1974, the four largest mining firms held a majority ownership interest in less than 19 percent of NSW copper output.[8]

**In general, the last 25 years has seen a broad diversification in ownership of capacity, followed by some contraction.** Diversification moves included more countries producing copper (recent market entrants include Papua New Guinea and Indonesia), increased government participation in mining (especially in Africa and South America), the acquisition and subsequent sale of copper operations by oil companies (primarily in North America), and the increased importance of independent (non-integrated) mining and smelting companies (e.g., the rise of the Japanese smelting industry; see ch. 4). This was followed in the last few years by the consolidation of many government-influenced enterprises, oil company divestitures, and increased integration.

## The Changing Ownership of Domestic Capacity

In the mid-to late-1800s, gold and silver discoveries could make or break an individual prospector, but copper deposits typically were financed first, by conglomerates "back East" that needed copper to feed the industrial revolution, and then by companies that already owned established mining properties. Thus, exploitation of the copper deposits on the Keeweenaw Peninsula of Michigan[9] was financed by companies in Boston. '" Firms that had their start in Butte, Montana (e.g., Amalgamated Copper Co., later to become Anaconda Minerals) provided capital to develop deposits in Arizona (e.g., the earliest Miami mines and the United Verde mine).[11]

Two trends fostered the initial concentration of ownership in the copper industry. First, established fabricators in the East were searching for new supplies as the U.S. economy advanced and people moved West. Thus Phelps, Dodge& Company (PD), a New York mercantile outfit that had entered the copper and brass fabricating business in 1845, purchased its first copper claim (the Atlanta) in Bisbee, Arizona in 1881 to secure its supply of raw materials. Today, PD is the largest U.S. copper producer, but is no longer in the fabricating business (see box 3-B).[12]

Second, with development of the mining industry, the amount of capital needed to finance a new venture increased rapidly. For instance, Phelps, Dodge and Company purchased the Atlanta claim for $40,000, and then spent 3 years of development work and an additional $95,000 just to find the main ore body.[13] Although initial capital investments often were sufficient to locate a deposit, or even begin production, additional financing usually was needed to maintain the competitive status of projects as the ore type and grade changed over time (e.g., the Douglas smelter mentioned in box 3-B).

Other investments were required because the state of technological development was rudimentary when a mine opened. In Globe, Arizona, for

[6]The corporate structure of the world copper industry, including the principal players, is discussed in ch. 9.

[7]Outside of the USSR.

[8]Raymond F. Mikesell, *The World Copper Industry: Structure and Economic Analysis* (Baltimore, MD: The Johns Hopkins Press, 1979), p. 28.

[9]The first major mines in the United States; see ch. 6.

[10]Donald Chaput, *The Cliff: America First Great Copper Mine* (Kalamazoo, Ml: Sequoia Press, 1971).

[11]Table 6-3 i, ch. 6 shows a detailed history of U.S. mine development, including initial and subsequent ownership.

[12]Lynn R. Bai Icy, *Bisbee: Queen of the Copper Camps* (Tucson, AZ: Western[ore Press, 1983).

[13]Ibid.

**Box 3-B.—Phelps Dodge and the Consolidation of Ownership**

Phelps Dodge began their first copper mining venture in Bisbee, Arizona in 1881 to feed their brass mills back East. At that time, they had numerous competitors in Bisbee. These included small operators with limited financial backing, as well as early mining conglomerates such as the Calumet & Arizona Mining Co., which was formed to operate the Irish Mag mine in Bisbee and later bought the New Cornelia claim in Ajo. PD began to consolidate their holdings in Bisbee within a couple of years, first with the purchase of the Copper Queen mine, whose underground workings had broken through into the Atlanta claim. The Copper Queen continued to produce until 1975. Over the next 20 years, PD bought several other claims and mines in Bisbee to improve the efficiency of their mine plans and ore processing. Their increased mine production, plus changes in the ore, led to construction of the Douglas smelter in 1904 (which closed in 1987), the largest and most modern smelter of its time.

In 1895 to 1896, PD also expanded into other parts of Arizona and Mexico by purchasing the Detroit Copper Co. and its properties in Clifton/Morenci and the Guggenheim interests near Nacozari, Mexico. In 1910, they acquired the claims in Tyrone, New Mexico. All of these areas are still producing copper, although PD is no longer involved in Nacozari. During the 1920s, PD added the Old Dominion mine in Globe, Arizona.

In 1929, PD went public. This provided them with an infusion of capital just before other companies began suffering huge losses due to the depression. During the 1930s, they purchased the Arizona Copper Company (the remaining claims in the Clifton area), and the Calumet & Arizona Company. PD's ownership status then remained relatively constant until the 1980s, when their production capacity began to decline due to the exhaustion of developed reserves in Bisbee, the impending exhaustion of sulfide ore at Tyrone, and the closure of the high-cost New Cornelia mine. In 1986, PD purchased Kennecott's two-thirds interest in Chino Mines in New Mexico.

example, the mine and smelter built around 1881 could" not handle the local carbonate ore very efficiently. New owners and an infusion of capital provided a branch railroad, a new smelter, and new underground mine development during the 1890s, which made the Old Dominion mine at Globe profitable.[14] Even where technological or other changes do not occur, a mine must expand into an ore body to maintain grade and output.

Capital became even more important in the early 1900s, when economies of scale (i.e., high capital cost but low unit operating costs) allowed development of low grade porphyry ore deposits and new types of smelters (see ch. **6).** The capability to exploit these ores profitably started the next wave of consolidation in ownership as companies scrambled to acquire rights to porphyry deposits held by individual prospectors. During this period, two other firms moved to consolidate their holdings within the domestic copper industry: Kennecott (dating from the early 1900s and financed in large part by Guggenheim family interests) became the other preeminent mining firm, and the American Smelting and Refining Company (now Asarco) was funded by Morgan banking interests to provide downstream processing. (Asarco originally owned and operated the smelter and refinery at Kennecott's Bingham Canyon mine,) Kennecott originally was formed to develop the Bonanza copper deposit in Alaska. Subsequently they acquired or developed mines in Ely, Nevada; Ray, Arizona; and Chino, New Mexico.

The search for mineral rights also extended to foreign countries, including the modern development of the first major properties in Chile, Peru, and northern Mexico (e.g., El Teniente and Chuquicamata in Chile, Cerro de Pasco in Peru, Cananea in Mexico). This represented the first major period of foreign expansion by Anaconda, Kennecott, and Asarco.

The next wave of new copper mines in the United States resulted from the increase in demand due to post-World War II industrial devel-

[14] Ira B. Joralemon, *Copper: The Encompassing Story of Mankind's First Metal* (Berkeley, CA: Howell-North Books, 1973).

opment and the technological advance that permitted exploitation of lower grade ore bodies. While most of the players remained the same, there were a few notable new entrants. Asarco went into the mining business in Arizona to provide feed for its own smelters. Newmont Mining Company (through various subsidiaries, including Magma), Cyprus Mines, and Duval also began copper mining in Arizona and Nevada. Inspiration began consolidating its holdings in Claypool, Arizona.

Then in the 1970s, major oil companies expanded into the copper business, in part as a response to increased government control of foreign oil operations, and in part for diversification given the projected rapid dwindling of oil reserves. Arco bought Anaconda, Amoco (Standard Oil of Indiana) acquired Cyprus Mines, Pennzoil purchased Duval, and Louisiana Land and Exploration bought Copper Range. SOHIO bought Kennecott, then British Petroleum (BP) took over SOHIO. Cities Service acquired Miami Copper (Arizona) and Tennessee Copper, then Occidental bought Cities Service. EXXON, Shell, Hudson Bay, and Superior Oil also purchased copper properties. By 1983, mines owned by oil companies accounted for around 10 percent of the total production from the world's 50 largest mines. [15]

The extensive movement of oil companies into the copper industry was greeted with enthusiasm because it was thought to mean large amounts of capital for capacity expansions and modernization to meet anticipated burgeoning demand. [16] However, most oil companies found this diversification venture disappointing. Their managers often did not understand the cost and operational implications of the huge tonnages of material needed to produce hard-rock minerals. The companies **also** did not fully anticipate the long payback periods for capital investment in nonfuel mining. The rapid drop in oil and copper prices and in copper demand in the early 1980s, plus the government appropriation of numerous foreign properties, compounded their cash flow problems. In the United States, only BP is still in the copper business, with one operation– Bingham Canyon. Cities Service sold its Arizona properties to Newmont. Amoco spun off Cyprus Minerals with sufficient capitalization to purchase additional mines. Arco/Anaconda sold its Arizona and Montana mines and wrote off the Nevada properties.

Since 1985, four other major shifts in ownership occurred in the U.S. copper industry. First, Copper Range–reorganized and staffed primarily with White Pine mine employees—bought the mine and smelter from Echo Bay. Copper Range is 70 percent owned by an Employees Stock Option Plan and 30 percent by Mine Management Resources. Second, Kennecott sold Ray Mines to Asarco (significantly increasing Asarco's presence in copper mining), and its share in Chino Mines to PD (partially replacing PD's soon-to-be-exhausted Tyrone deposit and closed Douglas smelter). Third, Newmont spun off Magma (including Pinto Valley) with sufficient recapitalization to finance modernization of the mine and smelter. Fourth, Cyprus Minerals acquired Duval's, Noranda's, and Inspiration's Arizona properties, making it the second largest copper producer in the United States.

## The Expansion of State Mining Enterprises

A second major change in the structure of the world copper industry resulted from a dramatic increase i n government participation in production–especially in less-developed countries (LDCs). In 1960, governments had some influence in less than 3 percent of all NSW copper mine capacity, but by 1970, about 43 percent of NSW capacity was owned in whole or in part by governmerits. ' [7] In 1981, governments owned a majority share in 35 percent of NSW copper mine capacity, but in LDCS the ownership shares were much larger; 73 percent of LDC capacity had at least 5 percent government ownership, while 62 percent had majority State ownership.

[15] Kenji Takeuchi *et al, The World Copper Industry: Its Changing Structure and Future Prospects* (Washington, DC: World Bank Staff Commodity Working Papers, Number 15, 1987).

[16] Louis J. Sousa, The *U.S. Copper Industry: Problems, Issues, and Outlook* (Washington, DC: Bureau of Mines, U.S. Department of the Interior, October 1981 ).

[17] Sir Ronald Prain, *Copper: The Anatomy of an Industry* (London: Mining Journal Books Ltd., 1975).

Government control of smelting and refining capacity was even greater (see table 3-1 ).[18] The Bureau of Mines estimates that 65 percent of NSW demonstrated copper resources in 1985 had government involvement through direct ownership of copper production, including 100 percent of Codelco (Chile) and 60 percent of Zambia Consolidated Copper Mines Ltd–ZCCM (Zambia)[19]– the two largest NSW copper producing companies,[20] The major ownership changes that contributed to this trend are discussed in box 3-C and shown in table **3-2.**

The expansion of State influence in copper production activities had an enormous effect on world copper markets in recent years. State investment decision making often is governed by objectives other than profitability; goals such as maintaining employment and self-reliance of supply or creating foreign exchange may carry as much or more weight. In Zambia, for example, maintaining copper production is essential because sales of the co-products, copper and cobalt, account for 90 percent of foreign exchange earnings. With such goals, production and marketing strategies in State mining enterprises are less sensitive in the short term to cyclical market fluctuations, unlike private operations that must react to declines in demand and price. As a result, State enterprises tend to produce at full capacity regardless of market conditions.

Over the long term, however, substantial operating losses will mean an inability to meet interest payments on debt. In Mexico, the $104 billion foreign debt, combined with the inefficient management and operating losses at State-run enterprises, led to a recently announced government policy of divestiture. The Cananea Mine and smelter, located about 15 miles south of the U.S. border in Sonora, is the first enterprise offered for sale. Cananea, which has a capacity of 160,000 tonnes per year, is owned by NAFINSA, a government bank. It is expected to generate around $100 million (U. S.) in export earnings in 1988. Cananea reportedly has not shown a profit for at least eleven years, however. Recently, the La Caridad mine and smelter (about 75 miles south of the border at Nacozari, Sonora) were added to the sales list. La Caridad is owned and operated by Mexicana de Cobre, the State copper firm .21

[18] Marian Radetzki, *State Mineral Enterprises* (Washington, DC: Resources for the Future, 1985),

[19] The Zambian percentage given here reflects a correction to the Bureau of Mines report made following a private conversation with the author of that report.

[20] U.S. Bureau of Mines, An *Appraisal of Minerals Availability for 34 Commodities* (Washington, DC: U.S. Department of the Interior, Bureau of Mines Bulletin 692, 1987).

[21] James H. Maish, "Planned Sale of Copper Mine Stirs Emotions in Cananea," *The Arizona Daily Star*, July 5, 1988,

**Table 3.1 .—Government Ownership in the Copper Industry, 1981**

| | Copper metal content | | |
|---|---|---|---|
| | Mining | Smelting | Refining |
| ***Western world:*** | | | |
| Total capacity (1,000 tons) | 7,820 | 8,780 | 9,120 |
| Percent of capacity with at least 5°/0 government ownership | 40.5 | 30.6 | 25.9 |
| Percent of capacity with majority government ownership | 34.7 | 29.7 | 24.3 |
| **Developing *countries:*** | | | |
| Total capacity (1 ,000 tons) | 4,120 | 3,340 | 2,580 |
| Percent of capacity with at least 5°/0 government ownership | 73.0 | 75.5 | 82.6 |
| Percent of capacity with majority government ownership | 62.0 | 72.9 | 77.0 |

SOURCE Marian Radetzki, *State Minera/ Enterprises* (Washington, DC Resources for the Future, 1988)

**Box** 3-C.— **Increased Government Control in the World Copper Industry**

The dramatic increase in government control over copper production facilities may be attributed primarily to the rise in nationalism in the early 1960s, **which led to a desire for sovereignty over local industry. Countries perceived mineral resources as part of their national heritage; control of those resources by foreigners was seen as at least improper and at most as thievery. Sovereignty over minerals was achieved through outright nationalization, through negotiations for majority share of ownership, or through legislation "encouraging" the sale of control to national firms. '**

**The wave of nationalizations began in Zaire in 1967. Shortly after achieving independence from Bel**gium, Zaire nationalized Union Miniere du Haut Katanga–the Belgian copper company formed in the late 1800s–and took over all of its assets and concessions. Generale Congolaise des Minerais (G EXAMINES) was formed to control copper mining. This was followed in 1969 by government "purchases" of a 51 percent interest in all mining properties in Zambia (ZCCM) and in the large mines in Chile (CODELCO). In 1971, the Chilean government passed a law in which the remaining interests in the major copper mines came under formal national control. Subsequently, Chile also set up a state-owned smelting and refining company —Empresa Nacional de Minera (ENAMI). Today, however, around 8 percent of Chile's production is from privately-owned mines, and this percentage will increase dramatically when the Escondida project opens.[2] In Zambia, management and marketing continued under the former owners until 1974, when these functions were taken over by the government. Government ownership increased to 60 percent in 1979.3

In 1974, Peru nationalized the Cerro de Pasco mine: and the La Oroya smelter/refinery, which have since been operated as a state enterprise (Centromin PeruS.A.). A second Peruvian government company, Minero Peru, was established to control a number of major undeveloped ore bodies formerly owned by large international companies, including Anaconda and Asarco. Minero Peru began production at Cerro Verde in 1977. A third company, Empresa Minera Especial Tintaya S.A. (Tintaya) was formed in the 1980s. In 1986, however, the Southern Peru Copper Company (SPCC–jointly owned by Asarco, Phelps Dodge, Newmont, and the Marmon Group) accounted for 61 percent of Peru's copper production (although all of SPCC's output is marketed by a government agency ).4

Finally, in the late 1970s, **Mexico passed legislation requiring a national equity share** in mineral properties. La Caridad **(44** percent owned by the Mexican government) started production in 1980. Subsequently, 92 percent of the ownership in the Cananea Mine (started in the late 1800s) passed to the Mexican government. [5]

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[1]Si mon Strauss, *Trouble in the Third Kingdom* (London: Mi ning Journal Books Ltd., 1986); Louis J. Sousa, *The* U.S. *Copper Industry: Problems, Issues, and Outlook* (Washington, DC. Bureau of Mines, U.S. Department of the Interior, Oct. 1981).

[2]The owners of the Escondida copper project are: The Broken H ill Pty. Co. Ltd. of Australia, 60 percent; Rio Ti nto Zi nc Corp. Ltd., 30 percent; and Mitsubishi Corp., 10 percent.

[3]Sousa, supra note 1; Kenji Takeuchi et al, *The World Copper Industry: Its Changing Structure and Future Prospects* (Washington, DC World Bank Staff Commodity Working Papers, No 15, 1987)

[4]Janice L W Jolly and Da niel Edelstei n, "Copper, preprint from *1986 Bureau of Mines Minerals Yearbook* (Washington, DC: U.S. Department of the Interior, Bureau of Mines, 1987)

[5]Takeuchi, su pra note 3: Jolly and Edelstei n, su pra note 4

## International Financing and Subsidization[22]

International financing for copper projects may be sought directly, or may be obtained by a government for general national development and then targeted for a copper project. A controversial aspect of increased government participation in world copper production capacity is the impact on production costs. Government-owned **or influenced operations are seen by private producers as receiving substantial cost benefits in the form of lower taxes, government-provided infrastructure, and low-cost financing.** They also are perceived as unresponsive to market condi-

[22]Unless otherwise noted, the discussion of international bank financing and its impacts on the domestic copper industry are from Jerry Krim, "The Confessional Financing of Mining Capacity, " paper presented at the conference on Public Policy and the Competitiveness of U.S. and Canadian Metals Production, Golden, CO, Jan. 27-30, 1987.

**Table 3-2.—Government Acquisitions of Copper Capacity**

| | | |
|---|---|---|
| 1967 | Gecamines, Zaire | 1000/0 nationalization |
| 1969 | Codelco, Chile | 51 % takeover of major mines |
| 1969 | NCCM/RCM, Zambia[a] | 51 % takeover of Zambia capacity |
| 1971 | Codelco, Chile | increase—51 % to 1000/0 |
| 1974 | Cerro de Pasco, Peru[b] | 1000/0 nationalization |
| 1977 | Cerro Verde, Peru | Start-up, 1000/0 government |
| 1979 | ZCCM, Zambia[c] | Government holding increased to 60°/0 |
| 1980 | La Caridad, Mexico | Start-up, 440/0 government |

aNchanga Consolidated Copper Mines, Ltd. (NCCM) and Roan Consolidated Copper Mines, Ltd (RCM).
bCerro de Pasco renamed Centromin.
cNCCM and RCM reorganized into ZCCM.

SOURCE: Marian Radetzki, *State Mineral Enterprises* (Washington, DC: Resources for the Future, 1985).

tions, and likely to be subsidized further during market downturns.

Low-cost financing is an especially touchy issue for domestic producers. State copper operations are largely i n developing countries where considerable funding comes from international financial institutions, such as the World Bank, the International Monetary Fund (IMF), the Inter-American Development Bank, the Asian Development Bank, and the African Development Bank. The multilateral development banks' overall goal is to improve the standard of living in LDCs. The IMF's goal is to promote international trade and a stable international monetary system; its loans are to governments for balance-of-payment purposes only, not specific ventures. Funds can be channeled into mining activities, however. For example, within the IMF, the Compensatory Financing Facility (CFF) assists governments that have balance of payments problems due to low prices for their principal commodity exports.

**The United States contributes to loans through these international banks and, by doing so, can be involved in the subsidization of competitors to the domestic mining industry** (i.e., to the extent that loans are granted at lower interest rates than could have been obtained without international bank participation; see below).

The major concerns of non-government copper producers with these financial arrangements include: 1 ) the comparative advantage to recipients of confessional financing, 2) the leverage effects of international financial institution lending, 3) the promotion of new or expanded copper production facilities without regard to current capacity or market conditions, and 4) the recipients resultant mounting debt.

Perceptions of the risk associated with a mining operation may be altered by the presence of international bank lending. While such loans generally represent a small portion of the capital needed for a project, international bank participation may provide more credibility to a project than it might otherwise have. The perceived reduction in risk may enable a mining venture to acquire financing at terms not available without international bank participation. This risk reduction is viewed as an advantage over competing private firms.

More than two-thirds of World Bank loans are provided at the interest rate at which the lending institution is able to obtain the funds. The U.S. Bureau of Mines estimates that a representative sample of loans made between 1980 and 1984 resulted in a net benefit to the borrower of 0.05 cents per pound of copper.[23] While this is less than 0.1 percent of the average price of copper during that period, it is important to note that Chile, the largest and one of the world's lowest cost copper producers, is a recipient of significant international bank financing.[24]

Perhaps the greatest impact from international bank financing on domestic copper producers in the 1980s has been the expansion of capacity in LDCs despite a world copper market already plagued by oversupply. During the 1982-85 slump, 60 percent of LDC copper producers maintained or increased production despite low prices and mounting inventories. Domestic output (and capacity) dropped sharply, while LDC

[23] *Comparison of International Financial Institutions and Private Sector Loan Terms for Non-Fuel Mineral Projects in Develop/rig Countries,* (prepared by Price Waterhouse for the Bureau of Mines, U.S. Department of the Interior, contract No. J0156023, May 1986).

[24] In December 1982, CO DELCO also obtained a $305 million *private* loan, the largest single foreign loan ever issued to Chile. The loan was financed by a syndicate of 25 foreign banks, including 14 in the United States. Janice L.W. Jolly and Daniel L. Edelstein, "Copper," 1982 *Bureau of Mines Minerals Yearbook* (Washington, DC: U.S. Department of the Interior, Bureau of Mines, 1983).

expansion, funded in part by such financing, exacerbated the situation.

Finally, countries that depend on copper exports for foreign exchange have mounting debt because copper price fluctuations adversely affected exchange earnings. These include Chile, Zambia, Zaire, Peru, and the Philippines–among our major world competitors. When copper prices were rising in the early 1970s, the trade balances and tax collections in these countries improved, and they were able to pay some of the interest on their foreign debt. When copper prices plummeted after the oil embargo and again in the early 1980s, however, their foreign exchange earnings and tax revenues also dropped. Their interest and amortization payments became troublesome, and all five countries had to borrow through the Compensatory Financing Facility. As of April 30, 1986, six countries had outstanding CFF/IMF loans totalling almost $1.4 billion that were tied to problems arising from the loss of copper export earnings.[25]

Recent studies on international bank financing impacts on domestic manufacturing and mining operations have led to a reassessment of U.S. contributions to such loans. Recommendations to reduce or eliminate U.S. participation where a loan may have a significant impact on domestic mining or manufacturing industries have surfaced several times in proposed trade legislation over the last few years. These bills either did not pass Congress or were vetoed by President Reagan (see ch. 10).

[25]Simon Strauss, *Trouble in the Third Kingdom* (London: Mining Journal Books Ltd., 1986).

## PRICE STRUCTURE

Copper is traded in various stages of processing including concentrate; blister and anode; refined, semi-fabricated, and fabricated products; and scrap (see figure 3-1 ). Within these stages exists an even broader range of classifications of copper products, such as old and new scrap, wirebars, ingot, cakes, billets, etc. Most copper is traded—and its price determined—as refined cathode and rod (i.e., refined metal at least 99.99 percent copper), however (figure 3-2). The price structures for other types of the metal are determined by refined copper prices.

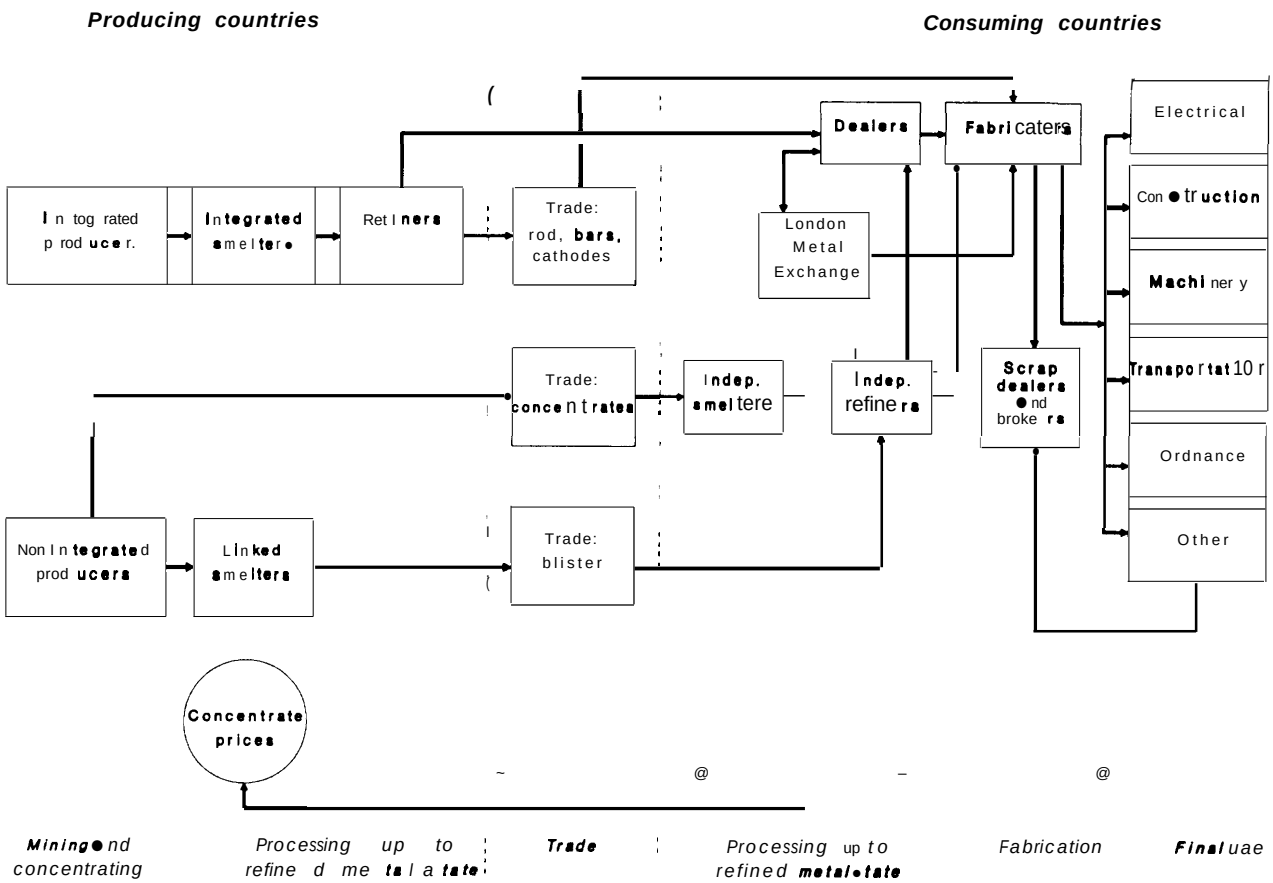
Copper may be sold either through contracts or on-the-spot trading on the commodity exchanges—the London Metal Exchange (LME) and the Commodity Exchange of New York (COMEX). Today, around 80 to 95 percent of trade involves contracts between refiners and semi-fabricators for cathode or rod; the remainder is sold in on-the-spot trading on the two exchanges. The players in these markets are described in box 3-D. Long-term contracts for ores and concentrates provide a hedge against market gluts, and lengthen the adjustment period when prices fall.

Copper is sold at commodity exchange prices, at prices published in journals such as ***Metals Week***, or at a published producer price. The ***Metals Week*** **price is a weighted average based on daily tonnages and sales prices. A producer price is based on productive capacity, probable demand, level of competition, and cost of production (see table 3-3). Prior to 1978, most domestic (and Canadian) copper trade was at producer prices. Changes in the commodity exchange prices were met by adjustments to the producer prices. In the late 1970s, most domestic producers switched to COMEX pricing.** Those still using the producer price have adopted flexible pricing policies, including more frequent adjustments in price following changes on the COMEX. Most transactions outside of the United States, including foreign shipments to domestic customers, are based on LME price quotations.

### The LME and COMEX

The amount of copper traded on the LME is a very small part of all copper trade, but this market plays an important role in setting the price. The LME serves as a “hedging” market–a clearing market for producers whose output exceeds their contracts, for small producers, and for accumulated inventories. Inventories in the LME are

**Figure 3-1.-Copper Market and Price Structure**




SOURCE Walter C Labys, *Market Structure, Bargaining Power, and Resource Price Formation* (Lexington, MA: D C. Health and Co , 1980)

an indicator of the balance of supply and demand in the world copper market (see below).

Copper is traded on the LME in the form of electrolytic cathode or high conductivity fire-refined copper in 25 tonne contracts. Delivery can be immediate (the next day) or in **3** months from approved LME warehouses. All trade occurs between the LME member and the customer. LME contracts usually do not contain a ***Force Majeure*** clause.[26] Margins and commissions are set by the exchange. z'

Price quotations on the LME are determined by transactions occurring during two daily trading sessions. These sessions last 5 minutes (1 2:00-12:05 pm and 3:40-3:45 pm, London time), with trade permitted to continue for 20 minutes following each session. Prices are quoted in pounds sterling and tenths of a pound sterling on a metric tonne basis, and may fluctuate without limit according to market activity. [28]

The COMEX differs from the LME in several ways. Trading on the COMEX is continuous from 9:50 am to 2:00 pm (New York time). COMEX prices are quoted in cents and tenths of a cent per pound of copper. Fluctuations in price are limited to 5 cents per pound per day.[29]

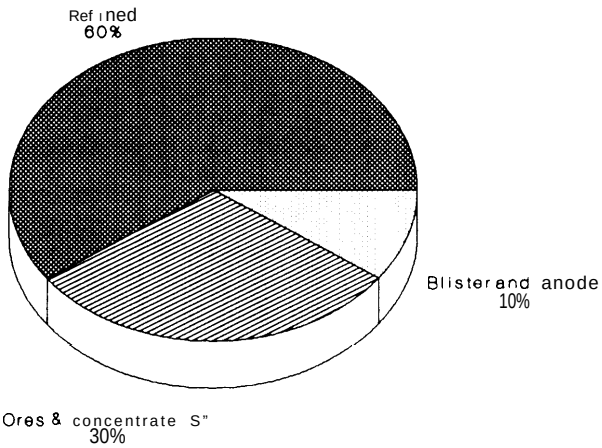
[26] A *Force Majeure* is invoked when the supply Of copper is curtailed for circumstances beyond the control of the parties involved, such as a strike or Inclement weather.

[27] Robert T. Keck, "Understand i ng the Copper Futures Market, *Forecast/rig Commodity Prices: How the Experts Analyze the Markets,* Harry Jiler (cd,) (New York, NY: Commodity Research Bureau, 1 975).

[28] Ibid.

[29] 1 bid

**Figure 3-2.-Most Copper Trade Occurs at the Refined Stage**




'Copper content
SOURCE: World Bureau of Metal Statistics data

**Table 3-3.—Major Copper Price Quotations**

| |
|---|
| ***London Metal Exchange (LME):*** |
| Electrolytic wire bars, cash for immediate delivery in warehouse. |
| Up to W-day delivery, electrolytic wire bars. |
| Cash, electrolytic copper in the form of cathodes, by grade. |
| W-day, electrolytic copper in the form of cathodes, by grade. |
| ***New York Producer Price:*** |
| Domestic refinery price (*E&MJ*),[a] electrolytic wire bars. |
| From January 1967, FOB domestic net Atlantic seaboard refinery. |
| Same price delivered which includes shipping cost. |
| Same price based on cathodes. |
| ***New York Commodity Exchange (COMEX):*** |
| Spot settlement price. |
| Futures Price. |
| ***Federal Republic of Germany:*** |
| Electrolytic comer wire bars |

[a]*Engineering and Mining Journal* price.

SOURCE: Walter C. Labys, *Market* Structure, *Bargaining Power, and Resource Price Formation* (Lexington, MA: D.C. Heath and Company, 19S0).

**Box 3-D.—Intermediaries in the Copper Market**

Agents.– Negotiate agreements between producers or consumers for a fee based on the value of the product sold.

Merchants.—Make direct purchases from producers and then sell the product to the highest bidder. Terms of acquisition are often more favorable than those obtained by agents or direct customer negotiation.

***Brokers.–Buy*** and sell orders on the active metals exchanges for producers, consumers, and investors for a fee. If a broker handles both the buy and sell order, a commission is received for both actions.

Also, on the COMEX, copper is traded in the form of electrolytic cathode, or high conductivity fire-refined in 25,000 pound (12.5 short-ton) contracts. Futures contract sellers must have sufficient copper to deliver when the contract is settled. The delivery period extends up to 14 months, with deliveries occurring in January, March, May, July, September, October, or December. Deliveries are made from COMEX-licensed warehouses located across the United States and the point of delivery is the option of the seller. All trade occurs through members, usually through a floor broker. Minimum margins and commissions are set by the exchange. A clearing house exists to record all member transactions and report net positions of the customers.[30]

## Direct Producer-Customer Contracts

Most copper trade involves transactions between refiners and semi-fabricators. Contracts for primary refined copper are usually for 1 year, A contract typically specifies the total annual tonnage and the monthly delivery limits within which the buyer can make purchases.[31] Other specifications include point of delivery, packing, etc. Unlike most commodities, the price is not specified, but stated more generally in a pricing clause such as "the seller's price at the time of delivery. ''[32]

Ores and concentrates usually are sold in long-term contracts of 1 to 10 years. These contracts may be linked to financial agreements in which a smelter may provide financing for resource de-

[30]Ibid.
[31]U.S. International Trade Commission (ITC), *Unwrought Copper: Report to the President on Investigation No. TA-201-52 Under Section 201 of the Trade Act of 1974,* ITC Publication 1549 (Washington, DC: ITC, July 1984).
[32]Walter C. Labys, *Market Structure, Bargaining Power, and Resource Price Formation* (Lexington, MA: D.C. Heath and Company, 1980).

velopment in return for a percentage share of the mine's output. For example, 15 percent of production from Phelps Dodge's Morenci mine is for the account of Sumitomo Corporation. These financing arrangements and many long-term concentrates contracts are designed to facilitate the flow of raw materials to smelters with insufficient or no mining resources.[33] As noted above, they also can ease adjustment to market fluctuations.

Concentrates may be sold to a smelter directly, or may be toll smelted (i.e., processed by the smelter/refinery for a fee and then returned to the producer). In either case, the value of the concentrate is calculated based on the price of refined copper. The price set by the smelter is determined by a basic formula: LME (or U.S. producer) price, times percent copper content, less conversion fee, less unwanted byproduct removal charge, plus precious metal sale credit, plus other byproduct sale credit, minus transport cost (if paid by the smelter) .34 **In practice, for both direct sales and toll smelting, the price will vary with the negotiated terms and conditions of the contract,** such as byproduct clauses and the economic and cost conditions at the time of purchase (i.e., exchange rates). Blister and anode copper are sold on similar terms, i.e., prices are a function of the LME refined price.

## The Role of Inventories

The structure of the copper industry is such that production usually cannot be increased quickly due to the long leadtimes for new or expanded capacity. Nor can production levels always be reduced rapidly or in small increments because economies of scale require minimum production levels and there are significant exit costs for shutting down capacity.

Therefore, consumers, producers, and speculators may stockpile copper to guard against (or profit from) shifts in supply and demand, inflation, and exchange rate adjustments. Speculators on the exchanges also may hold inventories in anticipation of price shifts. Finally, copper consumers may find themselves with unwanted inventories as a result of unanticipated reductions in demand for their products.

In general, producers and consumers maintain stocks as a precautionary measure. Continuation of supply is critical for most consumers, who may hold inventories to guard against possible supply disruptions and sudden price increases (e.g., due to labor strikes, transportation problems, or adverse weather). Producers may stockpile copper awaiting an increase in price, or in anticipation of events such as labor strikes in order to meet future contractual obligations. Both of these practices were more pronounced prior to the 1980s, when the cost of holding stocks was less significant to a company's balance sheet. Cost is less significant for those consumers who hold inventories to ensure an uninterrupted flow of materials for manufacturing activities that have a high down-time cost, however.

Because planned inventories are used by both copper producers and consumers as a "hedge," they are considered an important indicator of the balance between supply and demand. Changes in inventories mirror shifts i n market conditions, and significant changes are usually reflected in the market price. Short-term changes in inventories usually mean temporary or cyclical fluctuations in consumption or production. Long-term inventory surpluses or shortages may imply more fundamental structural changes in copper demand, such as decreased intensity of use or a need to expand world production capacity.

## Near-Term Price Determinants

Near-term prices (1 to 3 years) tend to fluctuate in response to normal business cycles through their effects on consumer demand. Price shifts may be exaggerated by speculative actions, however. For, example, in late 1987, copper prices began to rise as inventories dropped. The average price of copper for the first half of the year was about 66 cents per pound—up only a few cents from 1986. This minor increase, however, led to anticipation of a tighter copper market and a subsequent increase in copper sales to investors. The increased demand by speculators tightened the market even further, and by the end of 1987 spot prices had soared to nearly $1.50

[33] The smelters in Japan are almost completely reliant upOn i mreported raw materials to feed their facilities; see ch. 4.
[34] Labys, supra note 31.

per pound.[35] Some investment analysts even suggested that someone was trying to "corner" the copper market as the Hunt brothers had exploited market conditions in an attempt to corner the silver market in 1979.[36]

Near-term copper price movements also are tied to the relative inelasticity of world copper supply and demand, which in turn may mask longer-term effects. As noted previously, copper production capacity is slow to respond to both increases and decreases in demand. Thus, during the early 1980s, many major copper producers perceived the downturn in demand and price as part of the general economic recession. When copper prices were much slower to respond to the economic recovery in the United States than other sectors, however, more fundamental changes in the world copper industry (e.g., due to new market entrants, substitution, and third world debt) were recognized.

## Long-Term Price Determinants

**In the long term (5 years and beyond), prices are determined by the structure of the market, including:** the degree of ownership concentration (and thus market control) among producers and consumers; economic forces, such as technological change leading to radical shifts in production costs or consumer demand; and investment patterns, including the extent of government participation. For the copper industry, some noteworthy structural, economic, and technological factors may play an important role in long-run pricing. First, long-term contracts for ores and concentrates are likely to become more prevalent as the location of new smelting capacity is increasingly dictated by environmental concerns.

Second, concentration of ownership in the industry, particularly mining, has become more diluted. While the most recent sales of domestic capacity have, for the most part, meant fewer companies involved in domestic production, more countries have entered the market. While the trend toward State control of production at foreign copper properties is likely to continue, ownership probably will widen as burgeoning third world debt makes it increasingly difficult for LDCs to obtain project financing. Thus their cost of capital will be higher without significant private participation or development bank help.

Third, greenfield copper capacity additions have leveled off, and the surplus capacity that existed during the early 1980s is declining. While new capacity is planned for the next 5 years, it may be partially offset by exhaustion or cutback of existing operations, combined with demand growth created by new or expanded applications. Potential influences on future supply and demand are discussed—but not predicted—in more detail in chapter 4.

Fourth, the application of leaching and solvent extraction-electrowinning (SX-EW) technologies has made possible the recovery of copper from lower grade ores at a low cost. This is a double-edged sword for the domestic copper industry. While the United States has large oxide and waste dump reserves from which the domestic industry can produce copper for as low as 30 cents/lb, this production can exert downward pressure on world prices. Moreover, technology transfer in the copper industry is almost instantaneous, and SX-EW is particularly attractive to debt-ridden LDCs because of its low capital cost and undemanding operational requirements (see ch. 10).

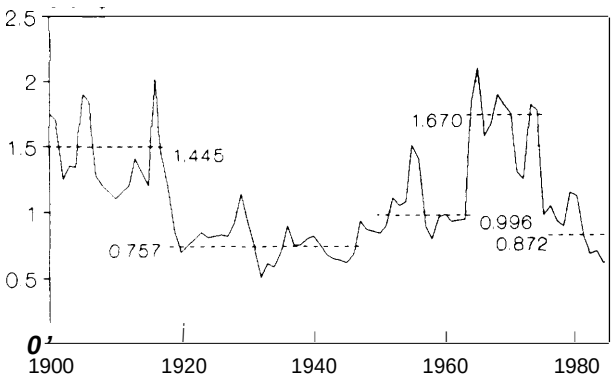
Technologies affecting demand also play an important role in setting long-term copper prices. The impact of these innovations is as uncertain as future supply, however. Even the effects of technologies now on the drawing board, such as superconducting materials and their applications, are highly uncertain (see ch. 4). Completely unanticipated innovations could make or break the copper industry by replacing the metal in critical applications or providing broad new uses.

## The Effects of Price Instability

Copper prices historically have been volatile (see figure 3-3). A large portion of copper consumption is in electricity, construction, and transportation— industrial sectors normally associated with economic growth and development. Copper demand is so sensitive to these sectors that it tends to fluctuate much more wildly than

[35] Ibid.
[36] "Who's Squeezing Copper, *Forbes,* Feb. 8, 1988.

**Figure 3-3.-London Copper Price**




SOURCE Kenjl Takeuchi, The *World Copper Industry* Its *Changing Structure and Future Prospects* (Washington, DC The World Bank, 1987)

they do (see box 3-E). Demand for copper grows radically during periods of industrial expansion and experiences severe declines when industrialization wanes. These swings in world demand are usually reflected in prices on the exchanges, where even a few large buy or sell orders can drastically affect short run prices.

Unstable copper prices create difficulties for both producers and consumers. Economic forecasting by management prior to deciding to proceed with an operation includes a prediction of anticipated copper prices. With volatile prices, such predictions are very difficult. Indeed, it was the relatively steady price increases of the late 1960s and early 1970s, combined with the increase in demand prompted by the Vietnam War, that encouraged the opening of so many new mines in the early 1970s. But the inability to predict the oil embargo with its ensuing recession quickly burst this bubble. A second severe recession within 5 years meant record copper inventories, and tolled the death knell for many mines. [37]

Unstable prices also make it difficult for copper consumers to plan their production line. For a given application (e. g., automobile radiators), copper may be the best choice at a given price. But if copper prices rise, aluminum or plastics may be preferred. If the manufacturer changes to another material, and then copper prices go down, he must decide whether to revert to copper. Frequent switches are difficult, however, because changes in raw materials usually mean changes in design, in production equipment, and in labor skills. [38]

If copper has certain properties that require that it be used regardless of cost, the manufacturer loses control of his production cost. Changes in the cost of copper may mean losses on inventories when prices go down, or more cash tied up in stocks when prices rise. Moreover, the consumer is faced with frequent adjustments to prices and difficulty in maintaining profit margins.[39]

Unstable copper prices also create major problems for countries that depend on copper exports for foreign exchange. When copper prices are high, such countries enjoy improved balances of trade and tax revenues, and are able to pay interest on their foreign debt. When copper prices are low, however, their foreign exchange earnings and tax revenues decline, and they may be forced to borrow from the Compensatory Financing Facility of the International Monetary Fund to meet interest and amortization payments. As noted previously, as of April 30, 1986, 6 countries had outstanding CFF/IMF loans totalling almost $1.4 billion that were tied to problems arising from loss of copper export earnings.[40]

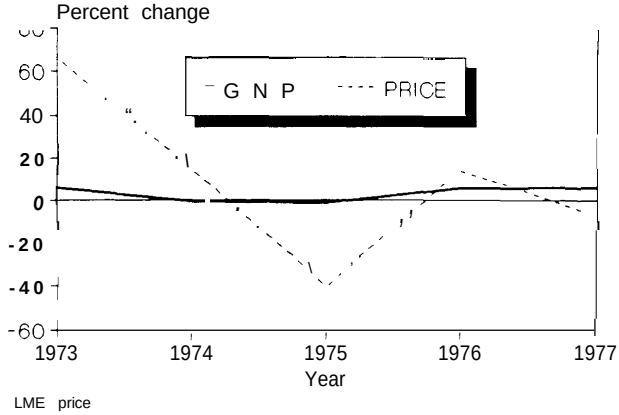
[37] Strauss, supra note 24.

[38] Ibid.

[39] Ibid.

[40] Ibid.

**Figure 3-4.-GNP Compared to Copper Price (1973-77)**




LME price

SOURCE Office of Technology Assessment.

### Box 3-E. —The Volatility of Copper Prices and Demand

Figure 3-4 contrasts the changes in U.S. gross national product (as an indicator of general economic growth) with the average annual copper price for the years 1973 to 1977. These were years of radical economic change. 1973 had been the year of greatest economic activity yet recorded. Then the boom halted abruptly in mid-1974 as the effects of the oil embargo began to be felt in steeply rising energy prices. This was followed by a severe recession in 1975, with fairly rapid recovery in 1976 to 1977. Despite these radical economic conditions, GNP fluctuated by only a few percentage points during 1973 to 1977. In contrast with the single-digit percentage changes in GNP during these years, copper prices rose or fell by double-digit percentages. The **price went from a 1972 (pre-oil embargo) average of 48.5 cents/lb on the London Metal Exchange, to a 1974 average of 93.1 cents/lb, and back to 59.4 cents/lb** for 1974.1

Demand also was very volatile over the same period, going from 2.2 million tonnes in 1973 and 1974, to almost 1.5 million tonnes in 1975. It then increased to 1.9 million tonnes in 1976 and 2.1 million tonnes in 1976 and 2.1 million tones in 1977.2 The volatility of copper consumption arises from the large proportion of demand that is linked to industrial capital expenditures, construction activity, and major consumer durable items such as automobiles and appliances.[3] In addition to general economic trends, U.S. copper demand in the 1970s was affected by significant structural changes related to substitution. Copper's intensity of use fell about 25 percent between 1970 and 1980, primarily due to automotive and products downsizing, design changes to conserve materials or increase efficiency, and substitution by aluminum.[4]

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1 U.S. Bureau of Mines, *Minerals Yearbook,* various years.

'I bid., U.S. consumption of primary copper plus old scrap.

'Simon Strauss, *Trouble in the Third Kingdom* (London: Mining Journal Books Ltd., 1986).

4U.S. Bureau of Mines and U.S. Department of Commerce, *Domestic Consumption Trends, 1972-82, and Forecasts to 1993 for Twelve Major Metals* (Washington, DC: U.S Department of the Interior, Bureau of Mines Open File Report 27-86, January 1986).