VERTICAL AND HORIZONTAL STRUCTURES IN THE COPPER INDUSTRY

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ABSTRACT

VERTICAL AND HORIZONTAL STRUCTURES IN THE COPPER INDUSTRY

By

Stanley Thomas Hardy

Firms in the copper industry are reputed to be linked with one another by a variety of means. Antitrust implications and the relative importance of the copper industry to the economy make this an important issue. This study is an attempt to examine these linkages, as they existed in 1962 among the major producers, processors, and sellers of copper in the free world. Vertical and horizontal linkages were recognized and separated so that the interconnections forming the vertical and horizontal structures were exposed.

The hypothesis tested was: in the copper industry there exists vertical and horizontal structures consisting of interconnections of ownership, joint membership in two or more vertically integrated groups, contractual relationships, and direct and indirect interlocking directorates.

The early part of this study describes the copper industry including its resource base, production processes, marketing operations, and flows of copper between major

producers and sellers. It is from the study of the copper flows that one is able to separate the vertically integrated groups from one another. Once the groups are separated, the balance of the study becomes feasible.

Interconnections between firms were discovered by collecting and sorting information as to ownership and contractual relationships among firms in the study. Affiliations of the executives and directors of the copper firms were investigated and tabulated so that the direct and indirect interlocking directorates might be revealed.

Classification of the interconnections was a problem that had to be overcome. Any two firms might readily be linked by more than one form of interconnection; therefore, to reduce the confusion, interconnections were ranked in order of their potential for control. The linkage was counted as the highest ranked interconnection.

This study reveals a vertical structure consisting primarily of ownership and/or contractual relationships. Beyond those associated with ownership, direct and indirect interlocking directorates were almost non-existent. The horizontal structure consisted primarily of indirect interlocking directorates followed in order of importance by ownership, joint membership, and direct interlocking directorates. Further, the industry is interconnected horizontally in approximately 60 percent of all possible points of interconnection.

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IN THE COPPER INDUSTRY

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Management

1969

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CHAPTER I

INTRODUCTION AND RESEARCH GOALS

The copper industry is reputed to be interconnected by a variety of means, both vertically and horizontally. The mechanisms utilized to accomplish this interconnection include ownership, contractual relationships, direct and indirect interlocking directorates, and joint membership in two or more vertically integrated groups.[1] Previous studies of the copper industry have exposed some of the direct and indirect interlocking directorate interconnections and, for the most part, have ignored the other forms of interconnection.[2]

This paper presents a study of all five interconnections existing in the copper industry in 1962. The vertical and horizontal structures are examined to determine the interconnections that are attributable to each type: ownership, joint membership, contractual relationship,

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[1] Joint membership is a special case of contractual relationships. See later section in this chapter for definitions.

[2] Federal Trade Commission, <u>The Copper Industry</u> (Washington, 1947), pp. 174-176. See also, Federal Trade Commission, <u>Interlocking Directorates</u> (Washington, 1951), pp. 173-175.

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direct interlock, and indirect interlock. The analysis of patterns of corporate interconnections may provide a basis for more clearly understanding the structure of the copper industry. Further, the implications raised by the findings of the study may provide future researchers grounds for examining the social and economic effects of corporate interconnections.

Importance of the Study

This study is important because of its approach to the study of corporate interconnections. The vertical and horizontal structures are examined separately so that the potential of the implications of each may be seen. Further, contrary to past studies, interconnections other than just direct and indirect interlocking directorates are studied so that more of the total network of corporate interconnections may be exposed.

Past studies of this type have been justified solely on the importance of the interlocking directorates. Arguments both for and against the practice of sharing common directors have been presented for some time.[3] Some claim that business benefits from common directors because the quality of management is raised, selling expenses are

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[3] Louis D. Brandeis, "Breaking the Money Trusts," Harper's Weekly, November 22, 1913 to January 17, 1914. See also U.S. Senate Committee on the Judiciary, Unlawful Restraints and Monopolies, Staff Report No. 698, 63d Congress, 2d Session, July 22, 1914.

reduced, and business investments are protected.[4] Others argue that such practices are objectionable and that they fall into three different classes: (1) conflicts of interest; (2) debasement of the quality of leadership; and (3) matters of antitrust significance.[5] The following paragraphs summarize the arguments.

The arguement that the quality of management is raised by the use of common or "outside" directors[6] is based upon the idea that these men have wider experience. Qualified management talent is scarce, and, by making the services of competent managers available to more corporations the scarcity is partially overcome. The experience gained by these directors in handling the problems of one firm, it is asserted, becomes an advantage to the others.

It is also argued that common directors may reduce the selling expense between interlocked corporations by providing an avenue of advantageous dealings between the firms.

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[4] Outside Directorships for Key Executives?" <u>The Conference Board Record</u>, October, 1965, p. 713. See also "What It Takes to Make the Board," <u>Business Week</u>, March 12, 1966, pp. 93-94. See also A. R. Towl, "Outside Directors Under Attack," <u>Harvard Business Review</u>, September-October, 1965, pp. 135-147.

[5] U.S. Congress, House, Antitrust Subcommittee of the Committee on the Judiciary, <u>Interlocks in Corporate Management</u>, 89th Congress, 1st Session, 1965, pp. 7-8.

[6] Common directors are often referred to as outside directors in many business publications.

common directors also can be beneficial, and at the same time not afford sufficient control to prevent independent operations, where investments in the other firms need to be protected and the common director can act as an avenue of information.

Conflicts of interest may arise when the interests of the stockholders are subordinated to personal gain afforded to a common director because of opportunities for inside dealing. Also, the common director has divided loyalties to the stockholders of the respective corporations. Should two companies have business dealings with each other and the interests of the two companies are in conflict, a common director faces a dilemma.

Debasement of management stems from the fact that opportunities to gain management experience is limited to only a few by a common management structure. Furthermore, a director serving several corporations may find his time limited so that he serves none well.

The antitrust implications of interlocking directorates deal with the possible reduction of competition. Common directors can serve as a liason between firms and assure that the pursuit of the best interests of one firm is not detrimental to the other. In competing firms, if the proportion of common directors is sufficient, competition may be eliminated entirely. Common directors of firms in closely related industries may forestall competition by preventing the firms from expanding into competing lines.

Further, common directors in firms having supplier-purchaser relationships may result in preferential treatment during periods of short supply and in preferential treatment in access to markets. Also, interlocks between manufacturing firms and financial institutions may result in favorable credit and capital supplied to one firm and in the withholding of credit and capital from competitors.

The government's interest in interlocking directorates stems from the antitrust implications. Legislation, in the form of the Clayton Act,[7] prohibits certain types of interlocks. Section 8 of this Act, in particular the part dealing with industrial and commercial corporations, provides the following:

> No person at the same time shall be a director in any two or more corporations, any one of which has capital, surplus, and undivided profits aggregating more than $1,000,000 engaged in whole or in part in commerce, other than banks, banking associations, trust companies, and common carriers subject to the Act to regulate commerce, approved February fourth, eighteen hundred and eighty seven, by virtue of their business and location of operation, competitors, so that the elimination of competition by agreement between them would constitute a violation of any of the provisions of any of the antitrust laws.

There are several apparent loopholes in this law. It should be noted that this law pertains only to directors and not to officers or employees. Furthermore, only direct horizontal interlocks are affected. The prohibition affects

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[7] Clayton Act, Public Law 212.

only corporations that are presently, or were in the past, competitors. Potential competitors are not affected. Hence, competition may never develop. Recent critics[8] of the law point to still other loopholes. Indirect interlocks between competitors, vertical interlocks between suppliers and customers, and interlocks between industrial and financial institutions are all legal under the Clayton Act. Yet, all have antitrust implications as previously discussed.

Copper, an Important Industry for Study

Copper, itself, is an important basic raw material. Sales of semi-fabricated copper to American industries exceeded one and one half million tons in 1962[9] and customers for this copper represented a broad spectrum of industries as can be seen in Table 1. Furthermore, the copper industry is reputed to have a long history of noncompetitive behavior. Throughout the latter half of the 19th century and the first half of this century, at least until World War II, the industry formed many international cartels to control price and production and to share the available markets.[10]

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[8] Interlocks in Corporate Management, op. cit., pp. 12-13 and 26-27.

[9] Metal Statistics, 1964 (New York: American Metal Market, 1965), p. 293.

[10] W. Y. Elliot et al., International Control in the Non-Ferrous Metals (New York: The Macmillan Company, 1937).

Table 1. Industrial consumers of copper[a]

Consumers	Percentage of Consumption
Electrical Equipment	19%
Light and Power	18
Building Construction	16
Industrial Equipment	10
Motor Vehicles	9
Communication	6
Military	6
Household Appliances	3
Railroad and Marine	3
Electronics	3
Scientific Equipment	2
Miscellaneous	5
Total	100%

[a] Copper and Brass Research Association, *Copper, The Cornerstone of Civilization* (New York: Copper and Brass Research Association, 1962), p. 3.

The industry has engaged in several overtly collusive actions.[11] It is known for its high degree of concentration of control over its ore reserves and production capacity.[12] Also, the industry is reputed to be highly interconnected via interlocking boards of directors not only among firms in the industry, but also with potential suppliers, customers, and sources of financial support.[13]

The importance of a study of the interlocking directorates with specific reference to the copper industry can readily be accepted. The task ahead, then, is to determine what has already been studied and to determine the structure of the present study.

Survey of the Literature

Although many studies of the copper industry have been made, few were concerned with, or even mentioned, interlocking directorates. Two studies, though, stand out from all the rest. One is the 1947 Federal Trade Commission Report, The Copper Industry,[14] and the other is also a

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[11] O. C. Herfindahl, Copper Costs and Prices: 1870-1957 (Baltimore: Johns Hopkins Press, 1959), pp. 73-142.

[12] Federal Trade Commission, The Copper Industry (Washington, 1947), p. 1.

[13] Interlocking Directorates, op. cit., pp. 173-175.

[14] The Copper Industry, op. cit.

Federal Trade Commission Report, Interlocking Directorates,[15] published in 1951.

The Copper Industry (1947)

The first study is one of a series by the Federal Trade Commission on basic industries exhibiting a high degree of concentration of control over their raw materials and production capacities. A part of this report deals with interlocking directorates in the copper industry as they existed in 1944. The Commission claimed that its study included firms producing 66 percent of the world output of primary copper in 1944, and that most of the firms were interconnected.

Its findings are summarized in Figure 1. Here the direct and indirect interlocking directorate interconnections of 15 copper corporations are exhibited. One can see that American Smelting and Refining is directly interlocked with Noranda with one common director. One can conclude that, through this direct interlock with Noranda, American Smelting and Refining is indirectly interlocked with Granby, Phelps Dodge, and Hudson Bay. Similar relationships of American Smelting and Refining, as well as the other 14 copper corporations, can be determined in a like manner.

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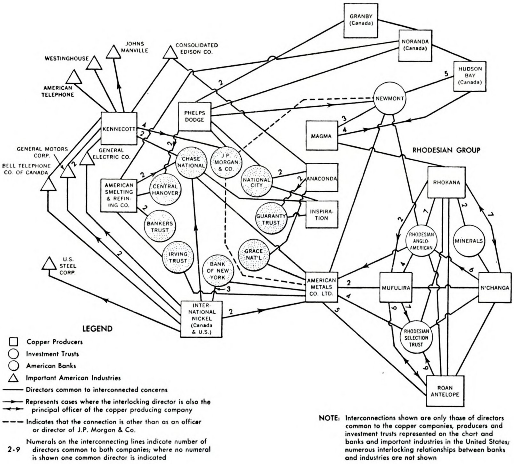
[15] Interlocking Directorates, op. cit.



NOTE: Interconnections shown are only those of directors common to the copper companies, producers and investment trusts represented on the chart and banks and important industries in the United States; numerous interlocking relationships between banks and industries are not shown

Figure 1. International interlocking connections between copper producers banks, investment trusts and important American industries. (Federal Trade Commission, The Copper Industry, 1947, opposite p. 175.)

Interlocking Directorates (1951)

The second study, started in 1948, is an attempt by the Commission to trace the important interlocking relationships stemming from the 1,000 largest manufacturing corporations in the United States, as measured by total assets. The study reports on interlocks existing as of 1946. Although all manufacturing groups are included, the study is broken down into separate industry studies. The non-ferrous metals industry includes the eight largest copper firms. The evidence developed in this study indicates that the eight copper firms were all inter-connected through interlocking directorates.

The commission concludes that the significant interlocks in the non-ferrous metals industry appeared to conform to three patterns[16]--access to markets, access to supplies of raw materials, and alliances with strong financial interests. The predominant pattern appeared to be the alliances with strong financial interests. This in turn supplied a substantial degree of interconnection, through indirect interlocks, between competing producers of non-ferrous metals.

These two studies have common shortcomings: (1) the samples were small, (2) there was no differentiation between a horizontal and vertical interconnection, and (3) interlocking directorates were considered to be the primary source of interconnection.

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[16] _Ibid._, pp. 173-175.

Definitions

Certain terms recur frequently throughout this study. The most common of these terms are defined below in order to minimize any confusion that might arise from their use.

Vertically Integrated Groups

Vertically integrated groups are defined as a group of firms all processing copper for sale through a single selling firm. The group includes the selling firm. All firms involved with the flow of copper to a single seller are defined to be a vertically integrated group as exhibited in Figure 2. The first type is a single channel group where all copper processed and sold by the group comes from a single source. The second type is a multiple channel group where the copper processed and sold by the group comes from two or more sources.

Vertical Structure

The vertical structure is defined as the interconnections between a member of a vertically integrated group and the selling firm of the group. These interconnections can be in the form of ownership, direct interlocking directorates, indirect interlocking directorates, or contractual relationships.

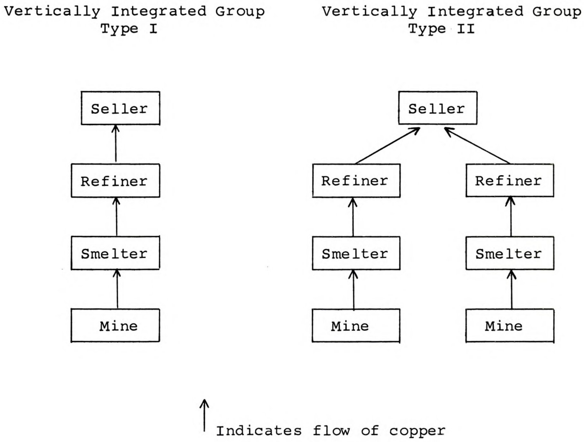


Figure 2. Vertically integrated groups defined by flows of copper.

Horizontal Structure

The horizontal structure is defined as the interconnections that exist among vertically integrated groups. The interconnections can be in the form of ownership, joint membership in two or more vertically integrated groups, direct interlocking directorates, or indirect interlocking directorates. Groups are considered to be horizontally interconnected even though the interconnection is between firms in different stages, such as an interconnection between a smelter from one group and a mine from another group.

Ownership Interconnections

An ownership interconnection is said to exist between Firm A and Firm B if any of the following conditions exist:

Condition 1. A owns all or part of B.

Condition 2. B owns all or part of A.

Condition 3. C owns all or part of A and B.

Examples of ownership interconnections in the vertical structure can be seen in Figure 3. If any of the above conditions exist between any member of Group I and Seller "A", such as Seller "A" owns Refiner "A", Refiner "A" owns Seller "A", or some firm "X" owns both Seller "A" and Refiner "B", the two firms, Seller "A" and Refiner "B", are said to be vertically interconnected by ownership.

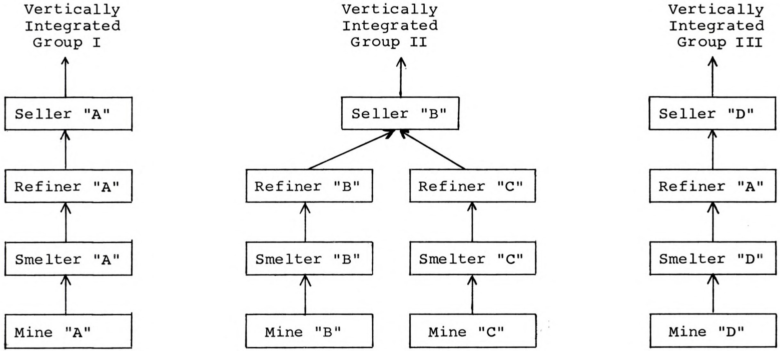


Figure 3. Three vertically integrated groups.

Examples of ownership interconnections in the horizontal structure can be seen in Figure 3. If any of the three conditions exist between any firm in Group I and any firm in Group II, such as an ownership interconnection between Refiner "A" and Seller "B", the two groups are said to be horizontally interconnected by ownership.

Direct Interlocking Directorates

A direct interlocking directorate is said to occur between Firm A and Firm B if any of the following conditions exist:

Condition 1. A and B share one or more common directors.

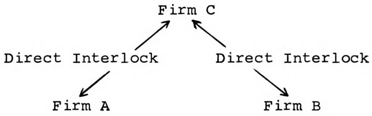
Condition 2. An executive officer of A sits on B's board of directors.

Condition 3. An executive officer of B sits on A's board of directors.

Examples of direct interlocking directorate interconnections can be seen by referring to Figure 3. If any of the three conditions exist between Seller "A" and any other member of Group I, the two firms are said to be vertically interconnected by direct interlocking directorates. Also if any of the three conditions exist between any member of Group I and any member of Group II, such as Refiner "A" and Smelter "B", the two groups are said to be horizontally interconnected by direct interlocking directorates.

Indirect Interlocking Directorates

An indirect interlocking directorate is said to exist between Firm A and Firm B if both Firm A and Firm B have a direct interlocking directorate with Firm C as illustrated here.



Examples of indirect interlocking directorate interconnections can be seen by referring to Figure 3. If any member firm of Group I is indirectly interlocked with Seller "A", the two firms are said to be vertically interconnected by indirect interlocking directorates. Also, if any firm in Group I is indirectly interlocked with any firm in Group II, the two groups are said to be horizontally interconnected by indirect interlocking directorates.

Contractual Relationships

Contractual relationships for processing copper can exist among members of a vertically integrated group. These contracts normally are one of two types: (1) the copper is treated on toll by a smelter and/or refiner and (2) the copper is sold directly to a smelter and/or refiner. In the first case the copper remains the property of the producer (mining company) and is brought to the market by the producer

or his agent. In the second case, the copper becomes the property of the smelter and/or refiner and they or their agents bring it to the market.

Both types of contracts specify all conditions of settlement, such as the percentage of total metal to be paid for or returned to the producer, the basic smelting and refining charges, penalties for impurities, bonuses for higher grade, payments for gold and silver, and time and rate of payment.[17] Further, these contracts are used to obtain minimum and maximum quantities of ores and concentrates.[18]

Joint Membership

Joint membership is a special case within the horizontal structure which is formed by the flow of copper from two or more vertically integrated groups moving jointly through a single processing unit. For example, in Figure 4, Group I and Group III use the same refiner, "A". Therefore, the two groups are horizontally interconnected by joint membership. Refiner "A" interconnects with Group I by ownership and Group III by contract.

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[17] A. D. McMahon, Copper, A Materials Survey (U.S. Department of the Interior, Bureau of Mines; Washington, D.C.: Government Printing Office, 1965), pp. 255-259.

[18] Ibid., p. 256.

Specific Research Goal

The specific research goal of this study is to examine the vertical and horizontal structures of the copper industry as of 1962. The copper firms in the sample include those said to be the principal producers of the free world copper.[19] The accomplishment of this goal necessitates the determination of the interconnections in both the vertical and horizontal structures that are attributable to each of the five forms of interconnection. The purpose is to test the hypothesis stated below:

> In the copper industry there exists vertical and horizontal structures consisting of interconnections of ownership, joint membership in two or more vertically integrated groups, contractual relationships, and direct and indirect interlocking directorates.

Differentiating the Structures

Why is it necessary to study the vertical and horizontal structures separately? The answers to this question lie in the different implications as to potential effects upon competition inherent in each structure.

The vertical structure is defined by the interconnections between members of a vertically integrated group

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[19] Yearbook--1962 (New York: American Bureau of Metal Statistics, 1963), p. 2425. The 69 firms in the sample produce, process, and sell 90 percent of the free world copper (H. Fasting, Director, American Bureau of Metals Statistics in private conversation with the author).

and the selling firm of the group. Each member of the group has a strong working relationship with the other members of the group. They all participate in the output and pricing policies for their group. The group is tied together by its flow of copper. Usually, no member is free to act alone. The mine needs the smelter to process its copper. The smelter needs the mine as a source of supply of raw materials; the smelter also needs the refiner to process its output. The refiner needs the smelter for raw materials and the seller as an access to the market. The seller in turn needs the refiner as a source of copper.

Under most circumstances it would be folly for any member to bolt the group. Either, or both, supplies of raw materials or access to markets for products would be nonexistent. Capacities of outputs and throughputs are relatively evenly balanced throughout the entire chain of production processes.[20] No other producer has the excess capacity to supply the renegade, nor does any other processor (smelter or refiner) have the capacity to take on the output of a new producer.

Since each member of a vertically integrated group needs each other there must be some negotiation, coordination, and agreement on output and pricing policies among the

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[20] R. H. Page, Secretary and Chief Agent, Rhodesian Selection Trust, in correspondence with the author indicated this to be true.

members. Therefore, one can say that such a group operates as a single firm.

The implications as to the potential effects upon competition have to do with barriers to entry. A new firm desirous of entering the copper industry must either start its own vertically integrated group or join an existing group. Capital requirements may be a very effective barrier in the first case. In the second case, the new firm is at the mercy of the already established groups. If the new firm is to join an established group, the members of the group must adjust their capacities to accommodate the new member. The group may be unwilling or unable to make this adjustment.

The horizontal structure is defined by the interconnections among the vertically integrated groups. The implications of this structure as to potential effects upon competition relate to output restrictions, market sharing, and price-fixing. This does not mean that an industry that has a large number of horizontal interconnections engages in non-competitive activities. Instead, it indicates that the industry has a potential to do so.

The differences, therefore, are that firms related vertically have the potential to restrict entry and firms related horizontally have the potential to restrict output and agree on market shares and prices.

Methodology

Three major problems arise as one attempts to study the vertical and horizontal structures of an industry. The first deals with determining where the interconnections exist. The second deals with identifying the interconnection as to whether it is vertical or horizontal. The third deals with classification of the interconnections.

The first problem, pertaining to the determination of the existence of interconnections, is one of collecting and sorting information. Data sources used were Poor's Register of Directors and Executives, Moody's Industrial Manual, Who's Who, and copper companies annual reports. All executives and directors of the copper firms in the study were listed along with their company affiliations on IBM cards. These data cards were then run through a computer program. The output of this program listed all direct interlocking connections of the copper firms both inside and outside the industry. The format of the data cards and the flow chart of the program are illustrated in Figures 4 and 5. By properly sorting the output cards, the direct and indirect interlocks can be determined.

Ownership information available from the same sources was tabulated. Therefore, all ownership interconnections of the firms in the study were listed for later use.

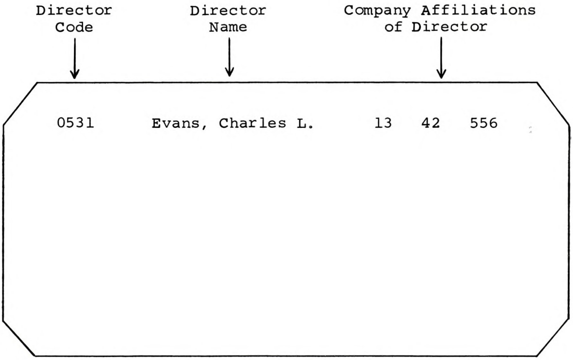
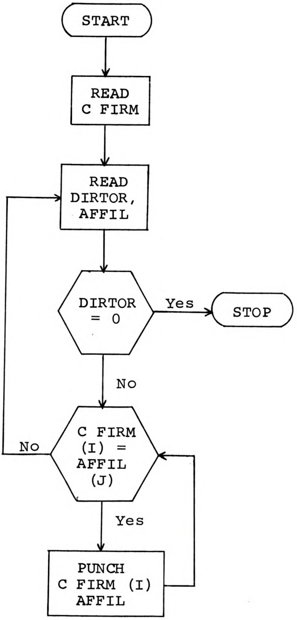


Figure 4. Data card for director or executive.



Read in coded copper firms

Read in director and all of his affiliations

If no more director cards stop

If director is affiliated with copper Firm (I) then copper Firm (I) is directly interlocked with all director's affiliations

Figure 5. Schematic program for punching direct interlocking directorate interconnections.

The second problem requires separating the industry into its vertically integrated groups. Using data supplied in the American Bureau of Metal Statistics Yearbook for 1962, one is able to determine that the industry consists of 21 distinct vertically integrated groups. These groups can be seen in Table 10 which appears in Chapter II.

The third problem requires ranking the various types of interconnections according to the potential control the interconnected firms might be able to exert on one another. It is quite likely that two firms could be interconnected by two or more types of interconnections. If there were an ownership interconnection, the two firms might readily share one or more common directors. If there were a direct interlocking directorate interconnection, it can be easily seen that this might also lead to an indirect interlocking directorate.

Table 2 displays the ranking of interconnections both in the horizontal and the vertical structures that were used in this study. The rationale for this ranking is based upon the potential power and control of one firm over another that the interconnection might provide. Power and control by type of interconnection is discussed below.

Ownership carries the right to decide upon courses of action and the ability to control the action of the owned firm. Because of this, ownership must be classed as having the highest potential for power and control over an interconnected firm.

Table 2. Interconnections ranked by potential power of control over interconnected firms

Type of Interconnection	Rank[a]
Horizontal Structure	
Ownership	1
Joint Membership	1
Direct Interlocking Directorate	2
Indirect Interlocking Directorate	3
Vertical Structure	
Ownership	1
Direct Interlocking Directorate	2
Indirect Interlocking Directorate	3
Contractual Relationships	4

[a] Rank depends upon number of directors involved. A contractual relationship may be stronger than either direct or indirect interlocking directorates.

Joint membership in two or more vertically integrated groups for the purpose of this study has the same potential in the horizontal structure as ownership. In this case a single firm interconnects two vertically integrated groups and it obviously controls its own actions. It should be noted that in all cases at least one of the vertical structures has a contractual relationship with the horizontally interconnecting firm.

Contractual relationships for processing copper exist only in the vertical structure. The firm is a member of a vertically integrated group and its power with the firms it interconnects depends upon the negotiating

capabilities of the members of the group. Similar to other members of the group, the firm with contractual relationships participates in output and pricing decisions. It is committed to the group on a long term basis as per the previous discussion on vertically integrated groups. Further, the contract usually controls maximum and minimum quantities of copper flows. (See definition of contractual relationships.)

Direct interlocking directorates have a potential power of control based upon the number of directors involved. One or two directors may do little other than act as an avenue of information. This, itself, may have serious implications to the state of competition. On the other hand, a large number of common directors in proportion to the size of the individual boards may be able to cause the two firms to act in consort and reduce competition.

Indirect interlocking directorates have potential power similar to direct interlocking directorates which depends upon the amount of directors involved.

Advantages

Advantages of this study are many. The examination of the structure of the industry, first for vertical interconnections and second for horizontal interconnections of vertically integrated groups, provides new insights to the significance of the interconnections. Also previous studies

are out of date and were based upon smaller samples than this study. Many interconnections missed by the previous studies may be discovered in this study. Further, the results of this study may lead other researchers to apply a similar methodology to other industries to determine if the industry structuring practices found to exist in the copper industry are universal.

Scope

This study is confined to the 69 firms listed by the American Bureau of Metal Statistics as the major producers, smelters, refiners, and sellers of copper in the free world. Although the copper industry consists of several hundred firms, this study was limited to the above mentioned firms because they produce more than 90 percent of the free world copper. Therefore, this study will be concerned with the interconnections, vertical and horizontal, of these 69 major copper firms.

Certain potential limitations in the findings of this study derive from the nature of the sample and the analytical procedures followed.

1. Not all the significant interlocking relationships may have been found. The sources are not always complete, especially with respect to foreign corporations.

2. Interlocking relationships have not been traced through all of the subsidiary and affiliated companies. The reason being that the number of such companies is large and

information is not always available publicly. In view of some of the large holding company systems that are to be found in the copper industry, this omission may result in a substantial understatement of the prevalence of interlocking relationships.

3. Business associates and familiar relationships have not been identified and traced as sources of interlocking relations unless they happen to be members of the same corporation. The gap is probably important, for relatives by blood or marriage and close business associates may be important links among the firms in the industry.

Organization of the Study

The study consists of four sections: (1) description of the copper industry; (2) the vertical structure of the industry; (3) the horizontal structure of the industry; and (4) summary and conclusions.

Description of the Copper Industry

The copper industry is described so that the reader may have a better understanding of the importance of the findings of this study. The description includes the firms in the industry sample and the flows of their copper.

Vertical Structure of the Industry

The vertical structure of the industry is analyzed to determine the basis for the structure. The interconnections examined are ownership, direct and indirect interlocking directorates, and contractual relationships.

Horizontal Structure of the Industry

The horizontal structure of the industry is analyzed to determine the basis for the structure. The interconnections examined are ownership, joint membership in two or more vertically integrated groups, and direct and indirect interlocking directorates.

Summary and Conclusions

The study is summarized and conclusions are drawn as to the validity of the hypothesis. Furthermore, a case for additional research is presented.

CHAPTER II

DESCRIPTION OF THE INDUSTRY

This chapter presents a description of the copper industry including its resource base, production processes, marketing operations, and the flows of copper between the major producers, and sellers. This description may provide the reader with some insights to understanding the industry structure exposed by this study.

Resource Base

Copper is a fund resource, which means that eventually we will have used up all naturally occurring copper. Fortunately, copper is also a recycling resource, with a use cycle considered to be approximately 40 years with a recovery of 60 percent.

Currently, 25 percent of the total consumption of copper is produced from old scrap.[1] Of the 51 million tons of copper produced in the United States since 1845, 32

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[1] A. B. McMahon, Copper, A Materials Survey (U.S. Department of Interior, Bureau of Mines, Washington, D.C.: U.S. Government Printing Office, 1965), p. 7, cited hereafter as Copper, A Materials Survey, 1965.

million tons are still in use, and 16 million tons have been recovered and reprocessed.[2]

Commercial deposits of copper are being worked on every continent, but 90 percent of the known deposits are located in five areas. These areas, listed in order of importance are: (1) The Rocky Mountains and the Great Basin area in the United States; (2) the Andes in Peru and Chile; (3) the Central Plateau in Africa; (4) the Pre-Cambrian area of Central Canada and Northern Michigan; and (5) the Urals in Russia, Siberia, and Turkestan.[3]

The total stated reserve of copper in the world is estimated at 212 million tons. According to the current rate of consumption, of four plus million tons per year, this should be a 40 to 50 year supply. A tabulation of reserves, continent by continent, and country by country can be found in Table 3. All quantities are measured or indicated reserves based upon the cost-price conditions of 1960. In other words, stated reserves are those which can be processed economically. Should the costs rise or the prices fall, the reserves will decrease, and should the costs fall or the prices rise, then the reserves will increase. It is interesting to note the changes in copper reserves in this

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[2] Ibid., p. 76.

[3] Copper, The Cornerstone of Civilization (New York: Copper and Brass Research Association, 1962), p. 8.

Table 3. World copper reserves[a]

Country	Ore Reserves Copper Content, Thousand Short Tons	Country	Ore Reserves Copper Content, Thousand Short Tons
North America:		Asia:	
Canada	8,400	China	3,000
Cuba	200	Cyprus	200
Haiti	75	India	100
Mexico	750	Israel	250
United States	32,500	Japan	1,200
Total	41,925	Philippines	1,000
		Turkey	580
		Total	6,330
South America:		Africa:	
Bolivia	55	Angola	40
Chile	46,000	Republic of the Congo	20,000
Peru	12,500	Northern Rhodesia	25,000
Total	58,555	Southern Rhodesia	475
Europe:		Kenya	20
Austria	60	Mauritania	460
Bulgaria	300	South-West Africa	525
Finland	750	Uganda	210
East Germany	500	Republic of South Africa	900
Ireland	280	Total	47,630
Norway	500		
Poland	11,400	Oceania:	
Spain	4,500	Australia	1,200
Sweden	700		
U.S.S.R.	35,000		
Yugoslavia	2,750		
Total	56,750	Grand Total	212,000

[a] Copper, A Materials Survey, op. cit., p. 44.

country over time. Production has increased, yet the reserves have more than kept up (see Table 4).

Table 4. Trend of U.S. copper reserve estimates[a]

Year	Tons Recoverable Copper	Price, Cents	Life, Years	Annual Rate of Production Used to Estimate Life, Tons
1931	At Least 18,500,000	9	31	600,000
1931	18,800,000	9	31	600,000
1934	18,900,000	10	32	600,000
1935	16,000,000 23,500,000	10 12	22 32	750,000
1936	23,700,000	12½	33	725,000
1944	20,000,000	13	25	800,000
1945	29,200,000	13	36	800,000
1960	32,500,000	32	30	1,100,000

[a] Copper, A Materials Survey, op. cit., p. 45.

The ore is generally low grade, between 0.4 percent and 10 percent copper, the balance being worthless gangue. The bodies of ore must be large in order to make operations profitable. The recently opened Palabora project in South Africa has reserves of 350 million tons of 0.69 percent ore and a smelter capacity of 80,000 tons of copper per year.[4]

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[4] Wall Street Journal, February 11, 1963, p. 21.

Generally other metals or minerals are found with copper, which permit the mining of low grade ore.

Ownership and control of the free world reserves of copper are highly concentrated. Three countries, United States, Britain, and Belgium, control approximately 83 percent of these reserves. Further, 70 percent of these reserves is in the hands of 10 corporations or financial groups.[5]

Production Processes

Mining.--The ore is mined either by open pit or underground mining operations. The underground operations are considerably more costly than open pit. A higher grade ore is required for profitable operation, 0.7 percent or more, while it is profitable to mine 0.4 percent ore in open pits.[6]

Extraction.--Copper is generally extracted by one or two methods:

1. Heat (concentration, smelting, and refining) or
2. Wet (flotation, leaching, smelting, and refining).

Where ore is low grade or has a poor composition, economy usually dictates the use of a wet process. Oxidized, mixed

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[5] The Copper Industry, op. cit., pp. 37-38.

[6] Copper, The Cornerstone of Civilization, op. cit., p. 9.

oxide-sulfide, and low grade native ores are commonly treated by this method. Very little copper is fire refined today. Michigan ores are fire refined, but this amounts to approximately 70,000 tons per year, or only 6 percent of the United States production. Other fire refineries are found in New Jersey, New Mexico, and Texas, and their capacity is 230,000 tons per year. The balance of the domestic production is electrolitically refined.

Fabrication.--Much of the copper continues on in the processing or fabricating plants of the copper and brass industry. Some of it is made into wire, some into sheets, plates, and rods, some into tubing, some into brass and bronze casting, and very little (10 percent) goes for initial fabrication outside the industry.[7] Therefore, industrial consumption starts with fabricated forms.

Production Costs

The industry is capital intensive and a great percentage of the costs are fixed as land, buildings, machinery, and equipment. Improved technology and substitution of capital for labor held costs per pound down in the face of rising wages for labor. Tables 5, 6, and 7 show productivity data for the mining, concentrating, smelting, and refining stages of the industry. Table 8 shows the cost per pound through the refining stage for several producers.

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[7] Ibid., p. 19.

Table 5. U.S. coppermine productivity--wages and labor cost 1931-60[a]

Year	Mined Copper, Recoverable Content, Thousand Pounds	Man-hours Worked, Thousand	Output per Man-hour in Pounds, Copper	Recoverable Copper in Ore, Percent	Total Ore Mined, Thousand Tons	Ore per Man-hour, Tons	Average Wage per Man-hour	Average Wage per Pound Metal	Average Wage per Ton Ore
1939	1,456,640	42,098	34.6	1.25	55,221	1.31	$0.68	$0.020	$0.518
1940	1,756,172	48,700	36.1	1.20	60.368	1.42	0.73	0.020	0.512
1941	1,916,298	55,100	34.8	1.15	78,343	1.42	0.79	0.023	0.558
1942	2,160,122	60,400	35.8	1.09	92,286	1.53	0.90	0.025	0.591
1943	2,181,636	60,689	35.9	1.04	98,120	1.67	1.01	0.027	0.603
1944	1,945,098	47,496	40.2	0.99	91,064	1.92	1.02	0.026	0.533
1945	1,545,788	35,474	43.6	0.93	77,473	2.18	1.04	0.029	0.479
1946	1,217,474	28,622	42.55	0.91	62,232	2.17	1.16	0.017	0.533
1947	1,695,126	38,264	44.3	0.90	87,865	2.30	1.32	0.030	0.575
1948	1,669,626	39,684	42.1	0.92	84,729	2.14	1.46	0.035	0.680
1949	1,505,500	34,730	43.3	0.91	76,033	2.20	1.51	0.035	0.687
1950	1,818,686	37,345	48.7	0.89	94,586	2.53	1.60	0.033	0.633
1951	1,856,660	39,677	46.8	0.90	95,494	2.41	1.70	0.036	0.704
1952	1,850,718	37,280	49.6	0.85	99,947	2.68	1.88	0.038	0.701
1953	1,852,896	39,488	46.9	0.85	101,065	2.56	2.00	0.043	0.781
1954	1,670,944	36,143	46.2	0.83	93,654	2.59	2.05	0.044	0.792
1955	1,997,140	40,500	49.3	0.83	112,550	2.78	2.17	0.044	0.781
1956	2,208,312	45,981	48.0	0.78	131,776	2.87	2.30	0.048	0.801
1957	2,173,718	41,452	52.4	0.77	129,716	3.13	2.39	0.046	0.784
1958	1,958,658	31,295	62.6	0.79	114,824	2.67	2.42	0.039	0.659
1959	1,649,692	26,382	62.5	0.74	103,716	3.93	2.51	0.042	0.639
1960	2,160,338	34,824	62.0	0.73	134,994	3.88	2.65	0.043	0.683

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[a] Copper, A Materials Survey, op. cit., p. 301.

Table 6. Productivity data of copper concentrators in the United States 1943-60[a]

Year	Employment		Production		Productivity		Labor Cost	
	Average Men Working Daily	Man-hours Worked, Thousands	Tons of Ore Milled, Thousands	Recoverable Copper Content, Thousands	Tons Ore Milled per Man-hour	Pounds of Recoverable Copper per Man-hour	Man-hour per Ton of Ore Milled	Man-hour per Pound Recoverable Copper
1943	7,095	19,797	92,247	1,794,992	4.66	90.67	.215	.01102
1944	6,558	18,104	86,393	1,628,392	4.77	89.95	.210	.01111
1945	5,891	15,521	58,521	1,030,280	4.71	82.85	.209	.01162
1946	5,579	12,436	58,521	1,030,280	4.71	82.85	.212	.01207
1947	5,846	15,100	83,283	1,454,598	5.52	96.33	.181	.01038
1948	6,208	15,998	80,098	1,420,094	5.01	88.77	.200	.01126
1949	6,582	15,526	72,019	1,287,342	3.64	82.92	.216	.01206
1950	5,828	15,731	90,206	1,583,886	5.73	100.69	.175	.00993
1951	6,033	16,205	91,021	1,590,528	5.62	98.15	.178	.01018
1952	6,141	16,969	95,307	1,571,652	5.62	92.62	.178	.01079
1953	6,243	17,254	96,595	1,587,658	5.60	92.02	.179	.01086
1954	7,096	16,699	89,620	1,421,714	5.37	85.14	.186	.01174
1955	6,222	15,854	108,061	1,745,040	6.82	110.07	.147	.00908
1956	6,683	18,400	127,251	1,915,828	6.92	104.12	.145	.00960
1957	7,083	18,095	124,640	1,899,106	6.89	104.95	.145	.00952
1958	6,468	14,618	114,028	1,758,916	7.80	120.33	.128	.00831
1959	5,588	11,156	103,239	1,496,508	9.25	134.14	.108	.00745
1960	5,230	13,129	134,306	1,926,408	10.23	146.73	.098	.00681

[a] *Copper, A Materials Survey*, *op. cit.*, p. 303.

Table 7. Productivity of smelters and refiners, combined[a]

Year	Average Men Working Daily	Man-hours Worked, Thousands	Smelter Production of Copper Thousands Pounds	Pounds Copper per Man-hour
1939	9,234	21,643	1,424,350	65.8
1940	10,743	25,092	1,818,168	72.5
1941	10,927	27,848	1,932,144	69.4
1942	10,286	27,911	2,175,982	78.0
1943	10,153	28,533	2,185,878	76.6
1944	7,728	21,733	2,066,758	92.3
1945	10,420	28,947	1,565,452	54.1
1946	10,187	23,573	1,199,312	50.9
1947	12,393	31,038	1,725,744	54.0
1948	12,419	32,496	1,684,954	51.9
1949	11,626	28,395	1,515,862	53.4
1950	11,756	30,402	1,822,704	60.0
1951	11,928	31,198	1,861,548	59.7
1952	10,629	27,508	1,854,730	67.4
1953	11,177	28,943	1,886,782	65.2
1954	11,244	27,316	1,668,762	61.1
1955	11,691	29,661	2,014,622	67.9
1956	12,194	31,497	2,235,160	71.0
1957	11,826	30,583	2,162,110	70.7
1958	10,801	26,966	1,985,836	73.6
1959	11,204	23,516	1,598,658	68.0
1960	12,009	29,445	2,285,696	77.6

[a] Copper, A Materials Survey, op. cit., p. 304.

Table 8. Cost per pound--five year moving averages of some leading copper producers[a] (cents per pound, U.S. equivalent)

Producers	1949-53	1950-54	1951-55	1952-56	1953-57	1954-58	1958 Copper Production, Thousand Pounds
Kennecott							
Before Taxes	11.103	12.027	13.078	14.475	15.862	16.346	637,464
After Taxes	16.779	18.319	20.685	23.169	24.314	24.216	
Phelps Dodge							
Before Taxes	12.240	13.460	14.600	15.810	16.230	15.690	437,148
After Taxes	17.140	18.920	21.010	23.020	23.540	22.840	
Greene Cananea							
Before Taxes	17.659	19.307	21.429	24.824	..[b]	..[b]	61,188
After Taxes	19.899	21.674	24.449	27.959	..[b]	..[b]	
Andes Copper							
Before Taxes	19.976	20.975	22.536	23.689	24.162[c]	23.697[c]	71,962
After Taxes	21.334	22.225	24.763	27.430	28.590[c]	28.395[c]	
Chile Copper Co.							
Before Taxes	14.497	15.375	15.969	16.780	17.115[c]	16.977[c]	469,198
After Taxes	18.737	19.695	21.961	24.134	25.154[c]	24.983[c]	
Branden							
Before Taxes	16.315	17.318	18.004	18.885	19.262	19.107	383,156
After Taxes	16.315	17.318	21.933	24.039	25.045	24.874	
Mulfulira							
Before Taxes	12.186	13.198	14.987	17.393	18.773	18.636	199,017
After Taxes	19.141	19.949	22.058	24.518	25.127	24.076	
Average							
Before Taxes	14.854	15.953	17.229	18.837	18.567	18.409	
After Taxes	18.888	20.147	22.408	24.894	25.295	24.897	
Total, 7 Companies							2,259,133
Total World, Including U.S.S.R.							7,200,000
Percentage of World Trade							31.38%

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[a] Copper Factbook, Supplement to an address before the Copper and Brass Research Institute at the 38th Annual Meeting, Hot Springs, Virginia, May 17, 1960, by Alvin W. Knoerr, ed., Engineering and Mining Journal and E. & M. Metal and Mineral Markets, p. 5.

[b] Not available.

[c] Estimated.

In 1960, labor costs, calculated from these tables, were approximately 8.5 cents per pound against the total production costs of approximately 18.5 cents.

Marketing Operations

The marketing operations in the copper industry usually are not apparent until the copper has been refined. The exceptions to this are those small mines that are not integrated with the major producers. They must sell their ores to custom smelters, often one of the major producers, or have the ore treated on the toll. The ores and concentrates are purchased based upon a contract between the mining company and the smelting company, which provides a schedule of prices to be paid depending upon the recoverable copper, the amount of gangue, and the impurities in the ore. If the ores are not treated on the toll basis, they become the property of the smelter who further refines them and sells the refined product at the most favorable time. Ores treated on the toll remain the property of the mining company and usually are sold immediately on the open market.

The typical marketing operation begins with the refined metal. In the United States, 50 percent of this metal goes directly to the wholly owned fabricators and no published prices are recorded for this exchange. The independent fabricators and the large electrical manufacturers buy directly from the large refiners, their selling agents, or on the open market. The copper typically is sold on a

30 to 90 day delivery from the refineries and priced in the month of shipment.[8]

Vertically Integration in the Industry

There are several hundred firms engaged in producing and selling copper throughout the free world. Most major producers are vertically integrated (via ownership) from the mining stage of operations through the smelting, refining, fabricating, and marketing stages. Other large firms are integrated through the smelting and refining stages; still others only mine and concentrate, shipping the concentrates to custom smelters and refiners. Table 9 depicts this structure by showing the principal copper producers, the mining companies, and the disposition of their copper through the smelting, refining, and selling companies.

The vertical integration of the industry can be seen more clearly if the information shown in Table 9 is reorganized. If, instead of grouping the industry by producers, the industry is grouped by selling firms, a pattern of 21 vertically integrated groups will appear as in Table 10. It should be noted that all but two of the producers are members of a vertically integrated group. The Chilean government sells the output of Mantos Blancos (21,000 tons in 1962).

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[8] Copper, A Materials Survey, op. cit., p. 45.

Table 9. Principal copper producers and the disposition of their copper[a]

Producer	Smelter	Refiner	Seller
United States			
Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
The Anaconda Company	The Anaconda Company	The Anaconda Company	The Anaconda Company
Appalachian Sulphides, Inc.	White Pine Copper Company	White Pine Copper Company	Appalachian Sulphides, Inc.
Bagdad Copper Corporation	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
Banner Mining Company	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
Calumet & Hecla, Inc.	Calumet & Hecla, Inc.	Calumet & Hecla, Inc.	Calumet & Hecla, Inc.
Copper Range Company	White Pine Copper Company	White Pine Copper Company	Copper Range Company
Duval Sulphur & Potash Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
Inspiration Consolidated Copper Company	Inspiration Consolidated Copper Company	Inspiration Consolidated Copper Company The Anaconda Company	The Anaconda Company
Kennecott Copper Corp.	Kennecott Copper Corp.	Kennecott Copper Corp. Amer. Smelting & Refining Co.	Kennecott Copper Corp.
Magma Copper Company	Magma Copper Company	Phelps Dodge Corporation	Magma Copper Company International Minerals & Metals Corporation
Phelps Dodge Corporation	Phelps Dodge Corporation	Phelps Dodge Corporation	Phelps Dodge Corporation
Pima Mining Company	Amer. Smelting & Refining Co.	American Metal Climax, Inc.	American Metal Climax, Inc.
Quincy Mining Company	Quincy Mining Company	Quincy Mining Company	Quincy Mining Company
Tennessee Corporation	Inspiration Consolidated Copper Company Phelps Dodge Corporation	The Anaconda Company Phelps Dodge Corporation	Adolph Lewisohn Corporation
White Pine Copper Co.	White Pine Copper Co.	White Pine Copper Co.	Copper Range Company

Table 9--Continued

Producer	Smelter	Refiner	Seller
		Canada	
Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
Atlantic Coast Copper, Corp.	Gaspe Copper Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Britannia Mining & Smelting Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Howe Sound Company
Campbell Chibougamau Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Patino Mining Company	Noranda Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Falconbridge Nickel Mines, Ltd.	Falconbridge Nickel Mines, Ltd.	Falconbridge Nickel Mines, Ltd.	Falconbridge, Nickel Mines, Ltd.
Gaspe Copper Mines, Ltd.	Gaspe Copper Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Geco Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Hudson Bay Mining & Smelting Co.	Hudson Bay Mining & Smelt. Co.	Canadian Copper Refiners	British Metal Corp.
International Nickel Co.	International Nickel Co.	International Nickel Co.	International Nickel Co. American Metal Climax, Inc.
Maritimes Mining Corp.	Gaspe Copper Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Noranda Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Normetal Mining Corp.	Noranda Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Opemiska Copper Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Quemont Mining Corp.	Noranda Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Sherritt Gordon Mines, Ltd.	Hudson Bay Mining & Smelt. Co.	Canadian Copper Refiners	Noranda Mines, Ltd.
Sullico Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.
Waite Amulet Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners	Noranda Mines, Ltd.

Table 9--Continued

Producer	Smelter	Refiner	Seller
		Mexico	
Companic Minera de Cananea	Compania Minear de Cananea	Cobre de Mexico The Anaconda Company	The Anaconda Company
Mazapil Copper Company	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	American Metal Climax, Inc.
		Other Foreign Countries	
Andes Copper Mining Company	Andes Copper Mining Company	The Anaconda Company	The Anaconda Company
Atlas Consolidated Mining & Development Corporation	Mitsubishi Metal Mining Co.	Mitsubishi Metal Mining Co.	Mitsubishi Metal Mining Co.
Bancroft Mines, Ltd.	Rhokana Corporation	Shipped as Blister	British Metal Corporation.
Braden Copper Company	Braden Copper Company	Braden Copper Company Kennecott Copper Corporation	Kennecott Copper Corporation
Cerro de Pasco Corporation	Cerro de Pasco Corporation	Cerro de Pasco Corporation	Cerro de Pasco Corporation
Chibuluma Mines, Ltd.	Mulfilira Copper Mines, Ltd.	Mulfilira Copper Mines, Ltd. Ndola Copper Refineries, Ltd.	American Metal Climax, Inc.
Chile Exploration Company	Chile Exploration Company	Chile Exploration Company The Anaconda Company	The Anaconda Company
Cyprus Mines Corporation	Various	Various	American Metal Climax, Inc.
Lepanto Consolidated	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
Union Minere du Haut Katanga	Union Minere du Haut Katanga	Union Minere du Haut Katanga Soc. General Metallurgique de Hoboken	Soc. General des Minerais
Kilembe Mines, Ltd.	Kilembe Mines, Ltd.	Shipped as Blister	British Metal Corporation
Mantos Blancos	Mantos Blancos	Shipped as Fire Refined	Various

Table 9--Continued

Producer	Smelter	Refiner	Seller
Mount Isa Mines, Ltd.	Mount Isa Mines, Ltd.	Copper Refineries Pty., Ltd.	Mount Isa Mines, Ltd.
Mufilira Copper Mines, Ltd.	Mufilira Copper Mines, Ltd.	Mufilira Copper Mines, Ltd.	American Metal Climax, Inc.
Nchanga Consolidated Mines, Ltd.	Rhokana Corporation	Nchanga Consolidated Mines, Ltd.	British Metal Corporation
O'Okiep Copper Company	O'Okiep Copper Company	Various	American Metal Climax, Inc.
Peko Mines, Ltd.	Various	Shipped as Concentrates	Duval Company, Ltd.
Rhokana Corporation	Rhokana Corporation	Rhodesia Copper Refineries, Ltd.	British Metal Corporation
Roan Antelope Copper Mines, Ltd.	Roan Antelope Copper Mines, Ltd.	Ndola Copper Refineries, Ltd.	American Metal Climax, Inc.
Santiago Mining Company	Santiago Mining Company	Shipped as Concentrates	The Anaconda Company
Southern Peru Copper Corp.	Southern Peru Copper Corp.	Various	Various
Tsumeb Corporation	American Smelting & Refining Company Soc. Gen. Metallurgique de Hoboken	Various	American Metal Climax, Inc.

[a] *Year Book, 1962* (New York: American Bureau of Metal Statistics, 1963), pp. 24-25.

Table 10. Principal copper sellers and the source of their copper[a]

Seller	Producer	Smelter	Refiner
Adolph Lewisohn Corporation	Tennessee Corporation	Tennessee Corporation	The Anaconda Company
		Inspiration Consolidated	The Anaconda Company
		Phelps Dodge Corporation	Phelps Dodge Corporation
American Metal Climax, Inc.	Pima Mining Company	Amer. Smelting & Refining Co.	American Metal Climax, Inc.
	International Nickel Co.	International Nickel Co.	International Nickel Co.
	Mazapil Copper Company	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
	Chibuluma Mines, Ltd.	Mulfilira Copper Mines, Ltd.	Mulfilira Copper Mines, Ltd.
			Ndola Copper Refineries, Ltd.
	Cyprus	Variou	Various
	Mulfilira Copper Mines, Ltd.	Mulfilira Copper Mines, Ltd.	Mulfilira Copper Mines, Ltd.
	O'Okiep Copper Company	O'Okiep Copper Company	Various
	Roan Antelope Copper Mines,Ltd.	Roan Antelope Copper Mines	Ndola Copper Refineries, Ltd.
	Tsumeb Corporation	Amer. Smelting & Refining Co.	Various
		Soc. Gen. Metal. De Hoboken	
Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
	Bagdad Copper Corporation	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
	Banner Mining Company	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
	Duval Sulphur & Potash Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
	Lepanto Consolidated	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
The Anaconda Company	The Anaconda Company	The Anaconda Company	The Anaconda Company
	Inspiration Consolidated Copper	Inspiration Consolidated Copper	Inspiration Consolidated Copper
			The Anaconda Company
	Companic Minera de Cananea	Companic Minera de Cananea	Cobre de Mexico
			The Anaconda Company
	Andes Copper Mining Company	Andes Copper Mining Company	The Anaconda Company
	Chile Exploration Company	Chile Exploration Company	The Anaconda Company
	Santiago Mining Company	Santiago Mining Company	Shipped as Concentrates
Appalachian Sulphides, Inc.	Appalachian Sulphides, Inc.	White Pine Copper Company	White Pine Copper Company
British Metal Corporation	Hudson Bay Mining & Smelting	Hudson Bay Mining & Smelting	Canadian Copper Refiners
	Bancroft Mines, Ltd.	Rhokana Corporation	Shipped as Blister
	Kilembe Mines, Ltd.	Kilembe Mines, Ltd.	Shipped as Blister
	Nchanga Consolidated Mines	Rhokana Corporation	Nchanga Consolidated Mines
			Rhodesia Copper Refineries
	Rhokana Corporation	Rhokana Corporation	Rhodesia Copper Refineries

Table 10--Continued

Seller	Producer	Smelter	Refiner
Calumet & Hecla, Inc.	Calumet & Hecla, Inc.	Calumet & Hecla, Inc.	Calumet & Hecla, Inc.
Cerro de Pasco Corporation	Cerro de Pasco Corporation	Cerro de Pasco Corporation	Cerro de Pasco Corporation
Copper Range Company	Copper Range Company	White Pine Copper Company	White Pine Copper Company
	White Pine Copper Company	White Pine Copper Company	White Pine Copper Company
Duval Sulphur & Potash Co.	Peko Mines, Ltd.	Various	Shipped as Concentrates
Falconbridge Nickel Mines, Ltd.	Falconbridge Nickel Mines, Ltd.	Falconbridge Nickel Mines, Ltd.	Falconbridge Nickel Mines, Ltd.
Howe Sound Company	Britannia Mining & Smelting Co.	Amer. Smelting & Refining Co.	Amer. Smelting & Refining Co.
International Nickel Company[b]	International Nickel Company	International Nickel Company	International Nickel Company
Kennecott Copper Corp.	Kennecott Copper Corp.	Kennecott Copper Corp.	Kennecott Copper Corp. Amer. Smelting & Refining Co.
	Braden Copper Company	Braden Copper Company	Braden Copper Company Kennecott Copper Corp.
Magma Copper Company[c]	Magma Copper Company	Magma Copper Company	Phelps Dodge Corporation
Mitsubishi Metal Mining	Atlas Consolidated	Mitsubishi Metal Mining	Mitsubishi Metal Mining
Mount Isa Mines, Ltd.	Mount Isa Mines, Ltd.	Mount Isa Mines, Ltd.	Copper Refineries
Noranda Mines, Ltd.	Atlantic Coast Copper, Corp.	Gaspe Copper Mines, Ltd.	Canadian Copper Refiners
	Campbell Chigougamau Mines	Noranda Mines, Ltd.	Canadian Copper Refiners
	Patino Mining Company	Noranda Mines, Ltd.	Canadian Copper Refiners
	Gaspe Copper Mines, Ltd.	Gaspe Copper Mines, Ltd.	Canadian Copper Refiners
	Geco Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners
	Maritimes Mining Corp.	Gaspe Copper Mines, Ltd.	Canadian Copper Refiners
	Noranda Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners
	Normetal Mining Corp.	Noranda Mines, Ltd.	Canadian Copper Refiners
	Opemiska Copper Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners
	Quemont Mining Corp.	Noranda Mines, Ltd.	Canadian Copper Refiners
	Sherritt Gordon Mines, Ltd.	Hudson Bay Mining & Smelting	Canadian Copper Refiners
	Sullico Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners
	Waite Amulet Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners

Table 10--<u>Continued</u>

Seller	Producer	Smelter	Refiner
Phelps Dodge Corporation	Phelps Dodge Corporation	Phelps Dodge Corporation	Phelps Dodge Corporation
Quincy Mining Company	Quincy Mining Company	Quincy Mining Company	Quincy Mining Company
Soc. General des Minerais	Union Minere du Haut Katanga	Union Minere du Haut Katanga	Soc. General Metallurgique de Hoboken

[a] Based upon Table 9. Note: Mantos Blancos and Southern Peru Copper Corporation not included, see text just prior to Table 9 for explanation.

[b] American Metal Climax, Inc. also sells for this group.

[c] International Minerals and Metals Corporation also sells for this group.

The other firm, Southern Peru Copper Corporation, is owned by several major copper producers, each taking their share of the copper output.

The significance of this vertical integration has been expressed by the copper industry itself. Industry leaders have indicated "it would be folly to enter the smelting or refining business without a source of material to be treated; from a practical standpoint, there is not much possibility of this."[9] Further, they have indicated that to open a mine without contracting for or constructing adequate smelting and refining capacity would be equal folly. Vertical integration is a necessity according to the copper industry.

Summary

From the foregoing, it can be seen that the copper industry has a high concentration of ownership and control over the naturally occurring resources. The major production processes of mining, smelting, and refining are capital intensive and each production unit is large in order to take advantages of economies of scale. The industry has been organized into vertically integrated groups because of this. Each element needs to be insured of either sources of supplies or markets for its output.

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[9] The Copper Industry, op. cit., pp. 32-47.

It is this vertically integrated structure that is to be examined in the next chapter. The questions to be answered have to do with the type of structure of each of the vertically integrated groups. Are they based upon ownership, interlocking directorates, or contractual relationships?

CHAPTER III

INTERCONNECTIONS WITHIN VERTICALLY INTEGRATED GROUPS

The purpose of this chapter is to describe interconnections existing within the vertically integrated groups in the copper industry. The Federal Trade Commission indicated that significant interlocking directorates would be found in these groups insuring access to supplies of raw materials and access to markets.[1]

Each group from the preceding chapter, identified by the selling company, will be examined for the apparent explanation for the organization of the group: ownership, direct and indirect interlocking directorates, or contractual relationships. If ownership exists, it is assumed to supercede the other three forms of organization. If a direct interlocking directorate exists, it is assumed to supercede an indirect interlocking directorate. Similarly, an indirect interlock supercedes a contractual relationship. Finally, if neither ownership nor an interlocking directorate

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[1] <u>Interlocking Directorates</u>, <u>op. cit</u>., pp. 173-175.

exists, it is assumed that the interconnection is based upon some contractual relationship.

The interconnections within groups are discussed below.[2]

Adolph Lewisohn Group

Producers	Smelters	Refiners
Tennessee Corporation	Tennessee Corporation	Anaconda Company
	Inspiration Consolidated Copper Company	Phelps Dodge Corporation
	Phelps Dodge Corporation	

The Adolph Lewisohn Company is a wholly owned subsidiary of the Tennessee Corporation, the producer. Some of the smelting and refining is performed by the Anaconda Company and the Phelps Dodge Copper Corporation on toll.[3] The relationships in this case are contractual.

The Tennessee Corporation is also vertically integrated into the fabrication stage with its wholly owned

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[2] All information presented in the remainder of this chapter can be found in the following sources: Poor's Register of Directors and Executives, Moody's Industrial Manual, Who's Who, and the individual copper companies annual reports.

[3] Metal smelted and refined on toll remains the property of the producing company.

subsidiaries, the New Haven Copper Corporation and the Chester Cable Corporation.

Producers	Smelters	Refiners
Pima Mining Company	Amer. Smelting & Refining Company	American Metal Climax, Inc.
International Nickel Co.	International Nickel Company	International Nickel Company
Mazapil Copper Company	Amer. Smelting & Refining Company	American Smelting & Refining Co.
Chibuluma Mines, Ltd.	Mufilira Copper Mines, Ltd.	Mufilira Copper Mines, Ltd. Ndola Copper Refineries, Ltd.
Cyprus Mines Corp.	Various	Various
Mufilira Copper Mines, Ltd.	Mufilira Copper Mines, Ltd.	Mufilira Copper Mines, Ltd.
O'Okiep Copper Company	O'Okiep Copper Company	Various
Roan Antelope Copper Mines, Ltd.	Roan Antelope Copper Mines, Ltd.	Ndola Copper Refineries, Ltd.
Tsumeb Corporation	Amer. Smelting & Refining Company Societe General Metallurgique de Hoboken	Various

American Metal Climax and its wholly owned subsidiary, the Anglo Metal Company, sell the copper produced by several firms in which the company has considerable ownership interests: Mazapil Copper, O'Okiep Copper, Tsumeb, Chibuluma Mines, Mufilira Mines, and Roan Antelope Copper

Mines. Ownership in the last three are derived from the company's 43 percent ownership of their parent company, Rhodesian Selection Trust. American Metal Climax, has similar ownership interests in the smelters and refiners of the copper from these companies with the exception of the American Smelting and Refining Company and the Societe Generale Metallurgique de Hoboken.

The company also sells some of the copper produced by the International Nickel Company probably on a contractual basis, even though the two companies share one common director. A similar situation exists with the copper produced by Cyprus Mines and its wholly owned subsidiary, Pima Mines. Cyprus Mines and American Metal Climax also share a common director, but their relationship is probably contractual. The smelting of Pima Mines copper is performed by the American Smelting and Refining Company on toll.

American Smelting and Refining Group

Producers	Smelters	Refiners
Amer. Smelting & Refining	Amer. Smelting & Refining Company	Amer. Smelting & Refining Co.
Bagdad Copper Corporation	Amer. Smelting & Refining Company	Amer. Smelting & Refining Co.
Banner Mining Company	Amer. Smelting & Refining Company	Amer. Smelting & Refining Co.
Duval Sulphur & Potash Co.	Amer. Smelting & Refining Company	Amer. Smelting & Refining Co.
Lepanto Consolidated	Amer. Smelting & Refining Company	Amer. Smelting & Refining Co.

All facilities for smelting and refining are owned by American Smelting and Refining as is the producing company by the same name. Bagdad Copper, Banner Mining, Duval Sulphur and Potash, and Lepanto Consolidated all sell their copper to American Smelting and Refining and their relationship to the company is contractual.

American Smelting and Refining is also vertically integrated into the fabrication stage. It wholly owns Federated Metals and has a 36 percent interest in General Cable and a 35 percent interest in Revere Copper and Brass.

Anaconda Group

Producers	Smelters	Refiners
The Anaconda Company	The Anaconda Company	The Anaconda Co.
Inspiration Consolidated Copper Co.	Inspiration Consolidated Copper Company	Inspiration Consolidated Co. The Anaconda Co.
Compania Minera de Cananea	Compania Minera de Cananea	Cobre de Mexico
Andes Copper Mining Co.	Andes Copper Mining Co.	The Anaconda Co.
Chile Exploration Company	Chile Exploration Co.	The Anaconda Co.
Santiago Mining Company	Santiago Mining Company	Shipped as Concentrates

All of the firms of this group, producers, smelters, and refiners, are owned by Anaconda. Further, Anaconda is

vertically integrated into the fabrication stage owning Anaconda Wire and Cable and Anaconda-American Brass.

Appalachian Sulphides Group

Producers	Smelters	Refiners
Appalachian Sulphides, Inc.	White Pine Copper Company	White Pine Copper Company

Appalachian Sulphides owns the producing company and the ore is treated on toll by the White Pine Copper Company. The interconnection is contractual.

British Metal Group

Producers	Smelters	Refiners
Hudson Bay Mining & Smelting Co.	Hudson Bay Mining & Smelting Co.	Canadian Copper Refiners, Ltd.
Bancroft Mines, Ltd.	Rhokana Corporation	Shipped as Blister
Kilembe Mines, Ltd.	Kilembe Mines, Ltd.	Shipped as Blister
Nchanga Consolidated Copper Mines, Ltd.	Rhokana Corporation	Nchanga Consolidated Copper Mines, Ltd. Rhodesia Copper Refineries
Rhokana Corporation	Rhokana Corporation	Rhodesia Copper Refineries

British Metal sells copper in England and Europe for several sub-groups. One of these sub-groups is owned by the Anglo-American Corporation. It consists of three producers,

Bancroft, Nchanga, and Rhokana; one smelter, Rhokana; and two refiners, Nchanga and Rhodesia Copper Refineries. A second group, Hudson Bay Mining and Smelting, has its copper refined on toll by Canadian Copper Refiners. The third group, Kilembe Mines, smelts its own copper and ships the blister copper[4] to British Metals.

Calumet and Hecla Group

Producers	Smelters	Refiners
Calumet and Hecla, Inc.	Calumet and Hecla, Inc.	Calumet and Hecla, Inc.

All of the firms in this group, producers, smelters, and refiners, are owned by Calumet and Hecla. Further, Calumet and Hecla is vertically integrated into the fabrication stage with its ownership of the Flexonics division and the Wolverine Tube Division.

Cerro Group

Producers	Smelters	Refiners
Cerro de Pasco Corporation	Cerro de Pasco Corporation	Cerro de Pasco Corporation

All of the firms in this group, producers, smelters, and refiners, are owned by Cerro.

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[5] Blister copper refers to copper that has been smelted and not refined.

Copper Range Group

Producers	Smelters	Refiners
Copper Range Co.	White Pine Copper Company	White Pine Copper Company
White Pine Copper Company	White Pine Copper Company	White Pine Copper Company

All of the firms in this group, producers, smelters, and refiners, are owned by Copper Range. Further Copper Range is vertically integrated into the fabrication stages with its ownership of the C. G. Hussey Company.

Duval Group

Producers	Smelters	Refiners
Peko Mines	Various	Shipped as Concentrates

Peko Mines, the producer, mines and concentrates only. The concentrates are then sold by contract by the Duval Company, Ltd.

Falconbridge Group

Producers	Smelters	Refiners
Falconbridge Nickel Mines, Ltd.	Falconbridge Nickel Mines, Ltd.	Falconbridge Nickel Mines, Ltd.

All of the firms in this group, producers, smelters, and refiners, are owned by Falconbridge.

Howe Sound Group

Producers	Smelters	Refiners
Britannia Mining & Smelting Company	American Smelting & Refining Company	American Smelting & Refining Company

The producing company, Britannia Mining and Smelting, is wholly owned by Howe Sound. American Smelting and Refining smelts and refines the copper on toll and the relationship to Howe Sound is contractual.

Howe Sound is also vertically integrated into the fabrication stage with its ownership of the Stamford Rolling Mills and the Electric Wire Company.

International Nickel Group

Producers	Smelters	Refiners
International Nickel Company	International Nickel Company	International Nickel Company

All the firms in this group are owned by International Nickel. A part of the copper produced by International Nickel is sold by the American Metal Company, a wholly owned subsidiary of the American Metal Climax Company. The relationship between American Metal Climax and International Nickel is probably contractual; although, the two companies share one common director.

Kennecott Group

Producers	Smelters	Refiners
Kennecott Copper Corporation	Kennecott Copper Corporation	Kennecott Copper Corporation
		American Smelting & Refining Co.
Braden Copper Co.	Braden Copper Co.	Braden Copper Co.
		Kennecott Copper Company

All firms in this group are owned by Kennecott with the exception of the American Smelting and Refining Company. The relationship between American Smelting and Refining and Kennecott is contractual (this relationship was dissolved in the mid-1960's). Kennecott is also vertically integrated into the fabrication stage with its ownership of the Chase Copper and Brass Company.

Magma Group

Producers	Smelters	Refiners
Magma Copper Co.	Magma Copper Co.	Phelps Dodge Corp.

Magma owns its producing and smelting companies and has its copper refined on toll by Phelps Dodge. Magma and Phelps Dodge are interconnected by contract. International Minerals and Metals Corporation, a metals wholesaler, sells some of Magma's copper. The relationship between these two

companies is probably contractual, even though they share one common director.

Mitsubishi Metal Mining Group

Producers	Smelters	Refiners
Atlas Consolidated Mining and Development Corporation	Mitsubishi Metal Mining Corp.	Mitsubishi Metal Mining Corp.

Mitsubishi buys on contract the concentrates of Atlas Consolidated Mining and Development Corporation.

Mount Isa Mines Group

Producers	Smelters	Refiners
Mount Isa Mines, Ltd.	Mount Isa Mines, Ltd.	Copper Refineries Pty., Ltd.

Both Mount Isa Mines and Copper Refineries are owned by American Metal Climax.[5]

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[5] Although this group is owned by American Metal Climax, it is included as a separate group because of a different selling agent.

Noranda Group

Producers	Smelters	Refiners
Atlantic Coast Copper Corp.	Gaspe Copper Mines, Ltd.	Canadian Copper Refiners, Ltd.
Campbell Chibougamau Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners, Ltd.
Gaspe Copper Mines, Ltd.	Gaspe Copper Mines, Ltd.	Canadian Copper Refiners, Ltd.
Geco Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners, Ltd.
Maritimes Mining Corp., Ltd.	Gaspe Copper Mines, Ltd.	Canadian Copper Refiners, Ltd.
Noranda Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners, Ltd.
Normetal Mining Corporation	Noranda Mines, Ltd.	Canadian Copper Refiners, Ltd.
Opemiska Copper Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners, Ltd.
Patino Mining Corporation	Noranda Mines, Ltd.	Canadian Copper Refiners, Ltd.
Quemont Mining Corporation	Noranda Mines, Ltd.	Canadian Copper Refiners, Ltd.
Sherritt Gordon Mines, Ltd.	Hudson Bay Mining & Smelting Co.	Canadian Copper Refiners, Ltd.
Sullico Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners, Ltd.
Waite Amulet Mines, Ltd.	Noranda Mines, Ltd.	Canadian Copper Refiners, Ltd.

Noranda owns directly 100 percent of Gaspe Copper Mines, 92 percent of Canadian Copper Refiners, and 95 percent of Waite Amulet Mines. Through Waite Amulet's ownership interest in the Mining Corporation of Canada, Noranda

indirectly owns 55 percent of Quemont Mining, 26 percent of Geco Mines, 50 percent of Normetal Mining, and 2 percent of Hudson Bay Mining and Smelting. The remaining producing companies sell their ores and concentrates to Noranda on contract.

Noranda is also vertically integrated into the fabrication stage with its 65 percent ownership of the Canadian Wire and Cable Corporation.

Phelps Dodge Group

Producer	Smelter	Refiner
Phelps Dodge Corp.	Phelps Dodge Corp.	Phelps Dodge Corp.

This group is wholly owned by Phelps Dodge as are several fabricating companies such as Phelps Dodge Copper Products Corporation and Habirshaw Wire and Cable Corporation.

Quincy Mining Group

Producer	Smelter	Refiner
Quincy Mining Co.	Quincy Mining Co.	Quincy Mining Co.

All facilities are owned by the Quincy Mining Company.

Societe Generale des Minerals Group

Producers	Smelters	Refiners
Union Miniere du Haut Katanga	Union Miniere du Haut Katanga	Union Miniere du Haut Katanga Societe Generale Metallurgique de Hoboken

Union Miniere owns controlling ownership in both the Societe Generale Metallurgique de Hoboken and the Societe Generale de Minerals.

Indirect Interlocking Directorates

The role of the indirect interlocking directorates also was examined in the structure of the vertically integrated groups. The findings were such that one might conclude that contractual relationships were the stronger interconnection between the selling firm and members of the group. Table 11 displays these findings, showing the firms interlocked, the total numbers of directors from the two firms meeting on other company boards, and the number of companies indirectly interlocking the two firms. For example, American Metal Climax and American Smelting and Refining are indirectly interlocked having common directors with three other firms. There are a total of eight directors from the two firms sitting on the boards of the other three firms. American Metal Climax shares one director with each of the three other firms. American Smelting and

Table 11. Indirect interlocking directorates between selling firms and members of the vertically integrated groups

Selling Firm	Member Firm	Directors Involved	Number of Companies Interlocking
American Metal Climax	Amer. Smelting & Refining	8	3
Amer. Smelting & Refining	Banner Mining	4	2
British Metal Corporation	Hudson Bay	2	1
British Metal Corporation	Kilembe	2	1
Howe Sound	Amer. Smelting & Refining	4	2

Refining shares two directors each with two of the other firms and one director with the third firm. The potential for control is rather weak.

Summary and Conclusions

The copper industry exhibits a definite tendency to organize itself into a set of vertically integrated groups. These groups generally consist of a set of producers, smelters, refiners, and a selling company. Many of these groups have carried vertical integration one step further into the fabrication stage. As previously discussed in Chapter II, the reason for such integration is to insure access to supplies of raw materials and markets for the products.

The vertically integrated groups appear to be organized on an ownership or contractual basis. Interlocking directorates were apparently not used as a vertical organization device. The isolated cases of direct interlocking directorates found to exist within groups consisted of firms sharing a single common director. Therefore, the relationships were considered to be too weak to be claimed as a basis for organization.

The next chapter will present an examination of the horizontal interconnections in the copper industry.

CHAPTER IV

HORIZONTAL INTERCONNECTIONS BETWEEN VERTICALLY INTEGRATED GROUPS

The purpose of this chapter is to present the results of an examination of the horizontal structure of the copper industry emphasizing interconnections between vertically integrated groups. The interconnections to be examined include ownership, joint membership in two or more vertically integrated groups, and direct and indirect interlocking directorates.

A problem arises when one begins such an analysis; there are 420 possible points of interconnections between the vertically integrated groups.[1] To analyze these interconnections, 6,642 possible pairings between individual firms must be analyzed. Further, each of these possible pairings must be examined for one of five conditions: no interconnection, ownership, joint membership, and direct and indirect interlocking directorates. This problem was solved by constructing a set of matrices displaying all possible interconnections as in Tables 12, 13, and 14.

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[1] There are 21 groups and each group has 20 possible interconnections.

Table 12 -- Ownership and joint membership interconnections in the horizontal structure.

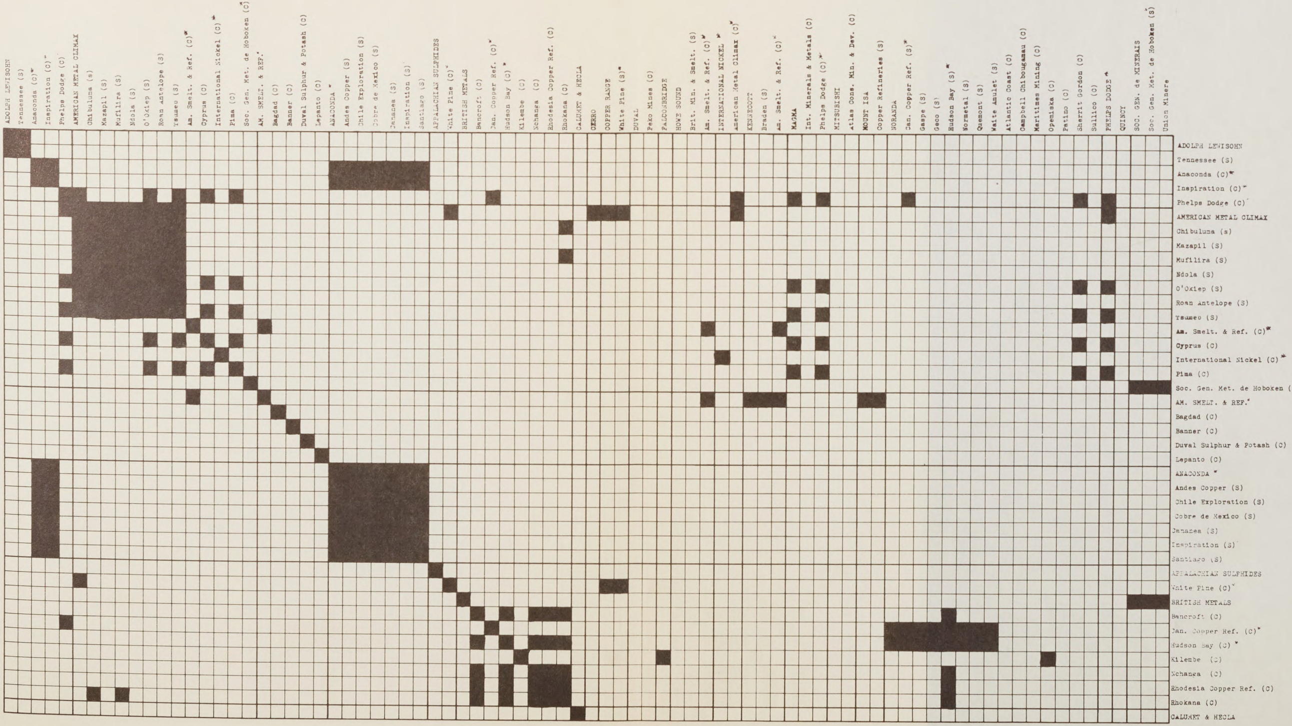

Table 12 -- Continued

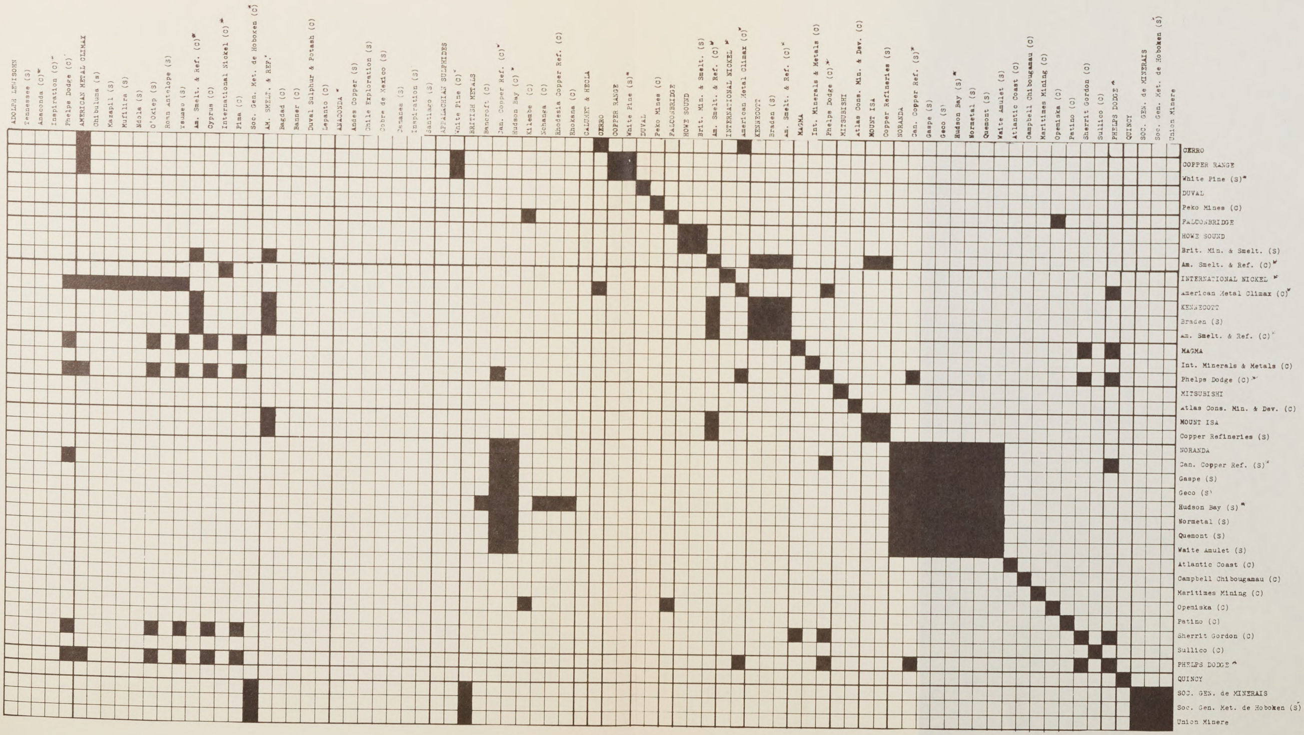

Table 13 -- Ownership, joint membership, and direct interlocking directorate interconnections in the horizontal structure.

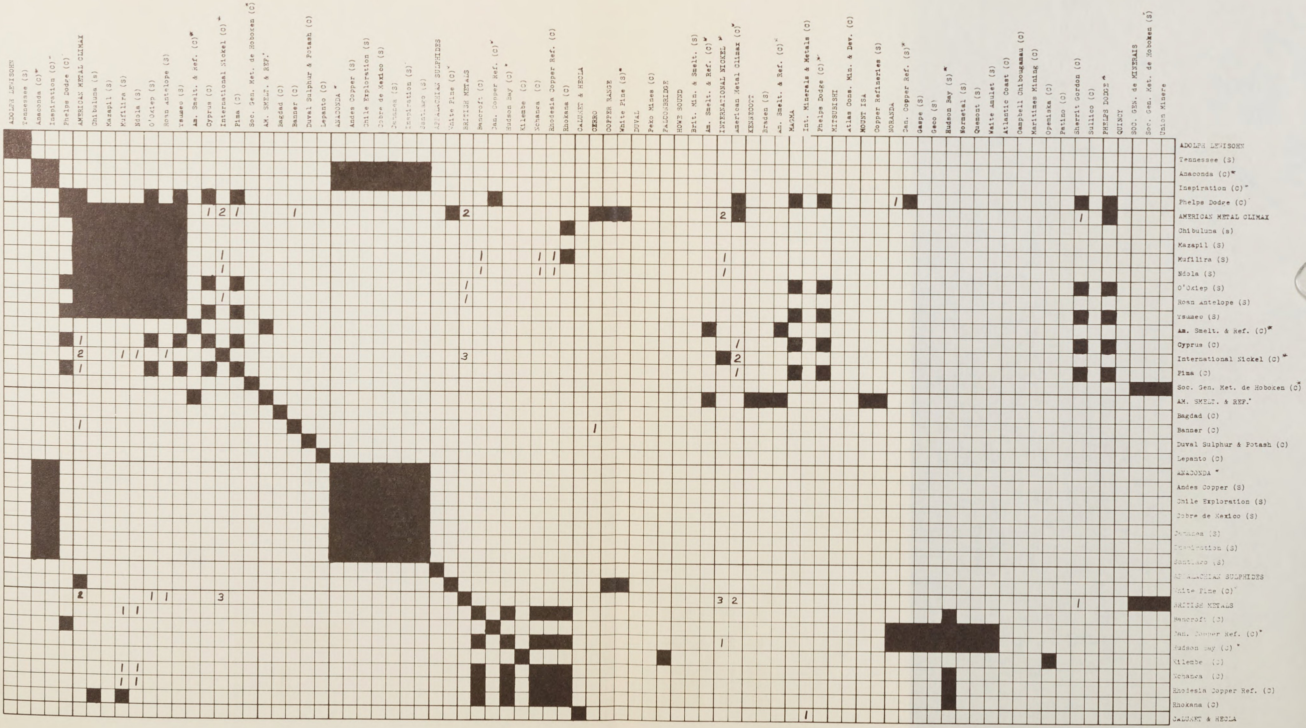

Table 13 -- Continued

	ADOLPH LEWISOHN	Tennessee (S)	Anaconda (C)*	Inspiration (C)*	Phelps Dodge (C)*	AMERICAN METAL CLIMAX	Chibuluma (s)	Mazapil (S)	Mufilira (S)	Ndola (S)	O'okiep (S)	Roan Antelope (S)	Tsumeb (S)	Am. Smelt. & Ref. (C)*	Cyprus (C)	International Nickel (C)*	Pima (C)	Soc. Gen. Met. de Hoboken (C)*	AM. SMELT. & REF.*	Bagdad (C)	Banner (C)	Duval Sulphur & Potash (C)	Lepanto (C)	ANACONDA*	Andes Copper (S)	Chile Exploration (S)	Cobre de Mexico (S)	Cananea (S)	Inspiration (S)	Santiago (S)	APPALACHIAN SULPHIDES	White Pine (C)*	BRITISH METALS	Bancroft (C)	Can. Copper Ref. (C)*	Hudson Bay (C)*	Kilembe (C)	Nchanga (C)	Rhodesia Copper Ref. (C)	Rhokana (C)	CALUMET & HECLA	CERRO	COPPER RANGE	White Pine (S)*	DUVAL	Peko Mines (C)	FALCONBRIDGE	HOWE SOUND	Brit. Min. & Smelt. (S)	Am. Smelt. & Ref. (C)*	INTERNATIONAL NICKEL*	American Metal Climax (C)*	KENNECOTT	Braden (S)	Am. Smelt. & Ref. (C)*	MAGMA	Int. Minerals & Metals (C)	Phelps Dodge (C)*	MITSUBISHI	Atlas Cons. Min. & Dev. (C)	MOUNT ISA	Copper Refineries (S)	NORANDA	Can. Copper Ref. (S)*	Gaspe (S)	Geco (S)	Hudson Bay (S)*	Normetal (S)	Quemont (S)	Waite Amulet (S)	Atlantic Coast (C)	Campbell Chibougamau (C)	Maritimes Mining (C)	Opemiska (C)	Patino (C)	Sherrit Gordon (C)	Sullico (C)	PHELPS DODGE*	QUINCY	SOC. GEN. de MINERAIS	Soc. Gen. Met. de Hoboken (S)	Union Minere
CERRO						■															1																					■										■				1																														
COPPER RANGE						■																										■											■	■																																									
White Pine (S)*						■																										■											■	■																																									
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HOWE SOUND																																																■	■																																					
Brit. Min. & Smelt. (S)																																																■	■																																					
Am. Smelt. & Ref. (C)*														■					■																															■			■	■	■						■	■																								
INTERNATIONAL NICKEL*						2			1	1						■																	3			1															■	2															1									1							
American Metal Climax (C)*					■	■	■	■	■	■	■	■	■		1	2	1				1												2									■									2	■						■																		1		■				
KENNECOTT														■					■																															■			■	■	■																															
Braden (S)														■					■																															■			■	■	■																															
Am. Smelt. & Ref. (C)*														■					■																															■			■	■	■																															
MAGMA					■						■		■		■		■																									1														■	1																			■		■				
Int. Minerals & Metals (C)																																									1															1	■																									
Phelps Dodge (C)*					■	■					■		■		■		■																		■																	■						■					1	■												■		■				
MITSUBISHI																																																											■																										
Atlas Cons. Min. & Dev. (C)																																																												■																									
MOUNT ISA																			■																															■											■	■																							
Copper Refineries (S)																			■																															■											■	■																							
NORANDA					1																														■	■																											■	■	■	■	■	■	■	■												
Can. Copper Ref. (S)*					■																														■	■																						■					■	■	■	■	■	■	■	■								■				
Gaspe (S)																																			■	■																											■	■	■	■	■	■	■	■												
Geco (S)																																			■	■																											■	■	■	■	■	■	■	■												
Hudson Bay (S)*																1																		■	■	■		■	■	■											1												■	■	■	■	■	■	■	■												
Normetal (S)																																			■	■																											■	■	■	■	■	■	■	■												
Quemont (S)																																			■	■																											■	■	■	■	■	■	■	■												
Waite Amulet (S)																																			■	■																											■	■	■	■	■	■	■	■												
Atlantic Coast (C)																																																																							■		1										
Campbell Chibougamau (C)																																																																								■										
Maritimes Mining (C)																																																																							1		■										
Opemiska (C)																																					■										■																											■								
Patino (C)																																															1																												■							
Sherrit Gordon (C)					■	1					■		■		■	1	■																1																		1	1				■		■																		■		■				
Sullico (C)																																																																													■					
PHELPS DODGE*					■	■					■		■		■		■																																			■						■					1	■												■		■				
QUINCY																																																																															■			
SOC. GEN. de MINERAIS																		■															■																																															■	■	■
Soc. Gen. Met. de Hoboken (S)																		■															■																																															■	■	■
Union Minere																		■															■																																															■	■	■

Table 14 -- Ownership, joint membership, direct and indirect interlocking directorate interconnections in the horizontal structure.

	ADOLPH LEWISOHN	Tennessee (S)	Anaconda (C)*	Inspiration (C)*	Phelps Dodge (C)	AMERICAN METAL CLIMAX	Chibuluma (s)	Mazapil (S)	Mufilira (S)	Ndola (S)	O'Okiep (S)	Roan Antelope (S)	Tsumeb (S)	Am. Smelt. & Ref. (C)*	Cyprus (C)	International Nickel (C)*	Pima (C)	Soc. Gen. Met. de Hoboken (C)*	AM. SMELT. & REF.*	Bagdad (C)	Banner (C)	Duval Sulphur & Potash (C)	Lepanto (C)	ANACONDA *	Andes Copper (S)	Chile Exploration (S)	Cobre de Mexico (S)	Cananea (S)	Inspiration (S)	Santiago (S)	APPALACHIAN SULPHIDES	White Pine (C)*	BRITISH METALS	Bancroft (C)	Can. Copper Ref. (C)*	Hudson Bay (C)*	Kilembe (C)	Nchanga (C)	Rhodesia Copper Ref. (C)	Rhokana (C)	CALUMET & HECLA	CERRO	COPPER RANGE	White Pine (S)*	DUVAL	Peko Mines (C)	FALCONBRIDGE	HOWE SOUND	Brit. Min. & Smelt. (S)	Am. Smelt. & Ref. (C)*	INTERNATIONAL NICKEL*	American Metal Climax (C)*	KENNECOTT	Braden (S)	Am. Smelt. & Ref. (C)*	MAGMA	Int. Minerals & Metals (C)	Phelps Dodge (C)*	MITSUBISHI	Atlas Cons. Min. & Dev. (C)	MOUNT ISA	Copper Refineries (S)	NORANDA	Can. Copper Ref. (S)*	Gaspe (S)	Geco (S)	Hudson Bay (S)*	Normetal (S)	Quemont (S)	Waite Amulet (S)	Atlantic Coast (C)	Campbell Chibougamau (C)	Maritimes Mining (C)	Opemiska (C)	Patino (C)	Sherritt Gordon (C)	Sullico (C)	PHELPS DODGE*	QUINCY	SOC. GEN. de MINERAIS	Soc. Gen. Met. de Hoboken (S)*	Union Miniere
ADOLPH LEWISOHN	■	■																																																2/1																															
Tennessee (S)	■	■			2/1	2/1																												8/1							2/1					4/2					2/1		4/2		6/2		2/1					4/2	8/1	7/2			2/1	2/1	7/2		2/1			8/4			2/1				
Anaconda (C)*			■	■	18/9	4/2			6/2	4/2		4/2		9/4	2/1	12/5			9/4		2/1			■	■	■	■	■	■	■		2/1	2/1		2/1							8/4		2/1			2/1	8/4		9/4	12/5	4/2	9/4	6/3	9/4	6/3		18/9						2/1	3/1	10/4						2/1						18/9				
Inspiration (C)*			■	■	2/1				2/1						2/1	3/1								■	■	■	■	■	■	■			2/1														2/1	2/1			3/1		6/3	2/1				2/1													2/1	2/1						2/1				
Phelps Dodge (C)		2/1	18/9	2/1	■	■			6/3		■	4/2	■	21/9	■	17/7	■		21/9		2/1			18/9	3/1				2/1		4/2		2/1		■	10/5	2/1				4/2	8/4	4/2				4/2	18/9		21/9	17/7	■	24/12	8/4	21/9	■		■					▨	■	21/5	5/2	10/5	9/2	7/1	10/1	2/1	4/2		2/1	2/1	■		■				
AMERICAN METAL CLIMAX		2/1	4/2		■	■	■	■	■	■	■	■	■	8/3	▨	▨	▨		8/3		▨			4/2	17/3	2/1					6/3	■	▨		4/2	6/3	2/1					■	■	■			2/1	9/4		8/3	▨	■		6/3	8/3	24/7	2/1							4/2	4/2		6/3	2/1	2/1			2/1				▨		■				
Chibuluma (s)						■	■	■	■	■	■	■	■																										■																																										
Mazapil (S)						■	■	■	■	■	■	■	■																																																																					
Mufilira (S)			6/3	2/1	8/3	■	■	■	■	■	■	■	■		4/2	▨	4/1		2/1		4/3			6/3	4/2			4/2	2/1				2/1	▨		2/1		▨	▨	■	2/1	4/1	4/2				4/2			2/1	▨		2/1		2/1			6/3									3/1	2/1				4/2				11/4		6/3				
Ndola (S)			4/2			■	■	■	■	■	■	■	■			▨								4/2	4/2			4/2					2/1	▨				▨	▨												▨																					2/1				2/1						
O'Okiep (S)					■	■	■	■	■	■	■	■	■	15/4	■	27/10	■		15/4	2/1	4/1												▨		4/2						4/2	13/4	4/2				2/1	6/3		15/4	27/10	■			15/4	■	3/1	■						4/2	2/1				4/2			4/2				■		■				
Roan Antelope (S)			4/2		4/2	■	■	■	■	■	■	■	■			▨	2/1				2/1			4/2	4/2			4/2					▨									4/2									▨					4/2		4/2																		9/4		4/2				
Tsumeb (S)					■	■	■	■	■	■	■	■	■		■		■																																							■		■																		■		■				
Am. Smelt. & Ref. (C)*					21/9	8/3					15/4			■	2/1	18/6			■		4/2			9/4	4/2	2/1		2/1					2/1		6/3						3/2	24/8					2/1	4/2		■	18/6	8/3	■	■	■	23/8	2/1	23/9							10/5	10/6		2/1			6/3				8/4	11/2		21/9				
Cyprus (C)			2/1	2/1	■	▨			4/2		■		■	2/1	■	4/2	■				4/2			2/1	2/1			2/1			2/1	4/2			2/1	2/1					2/1	2/1	2/1	4/2				6/3			4/2	▨	2/1	4/2		■		■						2/1	4/2	2/1	2/1	6/3	2/1	2/1	2/1	6/3				■		■				
International Nickel (C)*			12/5		17/7	▨			▨	▨	27/10	▨		18/6	4/2	■	2/1		18/6	2/1	6/3			12/5	17/5			5/2			2/1	6/3	▨		23/9	22/8					4/2	23/10		6/3			13/5	12/5			■	▨	14/6	23/11		14/6	2/1	17/7					4/2	23/9	30/14	21/7	23/8	14/7	15/5	12/10	12/6	15/7		6/3	2/1	22/22		17/7				
Pima (C)					■	▨			4/1		■	2/1	■		■	2/1	■				2/1																				2/1	2/1						2/1			2/1	▨				■	2/1	■										2/1								■		■	2/1			
Soc. Gen. Met. de Hoboken (C)*																		■																																																														■	■	■
AM. SMELT. & REF.*			9/4		21/9	8/3			2/1		15/4			■	2/1	18/6			■		4/2			9/4	4/2	2/1		2/1					2/1								3/2	24/8					2/1	4/2		■	18/6	8/3	■	■	■	23/8	2/1	21/9			■	■			10/5	19/6		2/1			6/3				8/4	11/2		21/9				
Bagdad (C)											2/1					2/1				■																															2/1			8/4		2/1									2/1						2/1				2/1							
Banner (C)			2/1		2/1	▨			4/3		4/1	2/1		4/2	4/2	6/3	2/1		4/2		■			2/1	4/2							4/2										▨		4/2			4/2			4/2	6/3		4/2	2/1	4/2	2/1	2/1	2/1					2/1		4/2	10/4		2/1				2/1		2/1	2/1	2/1		2/1				
Duval Sulphur & Potash (C)																						■																																																												
Lepanto (C)																							■																																																											
ANACONDA *			■	■	18/9	4/2			6/3	4/2		4/2		9/4	2/1	12/5			9/4		2/1			■	■	■	■	■	■	■		2/1	2/1		2/1							8/4		2/1			2/1	8/4		9/4	12/5	4/2	9/4	6/3	9/4	6/3		18/9						2/1	8/4	10/4						2/1						18/9				
Andes Copper (S)			■	■	8/1	17/3			4/2	4/2		4/2		4/2	2/1	17/5					4/2			■	■	■	■	■	■	■	2/1					10/2					8/3		9/2				8/1	4/2		4/2	17/5	17/3	4/2		4/2			8/1														4/2						8/1	4/2			
Chile Exploration (S)			■	■								2/1		2/1					2/1					■	■	■	■	■	■	■																					2/1		2/1	2/1		2/1																											
Cobre de Mexico (S)			■	■																				■	■	■	■	■	■	■																																																				
Cananea (S)			■	■					4/2	4/2		4/2		2/1		5/2								■	■	■	■	■	■	■																				2/1	5/2		2/1		2/1																	2/1										
Inspiration (S)			■	■	2/1				2/1	4/2		4/2			2/1									■	■	■	■	■	■	■			2/1														2/1	2/1					6/3	2/1				2/1													2/1	2/1						2/1				
Santiago (S)			■	■																				■	■	■	■	■	■	■																							2/1																													
APPALACHIAN SULPHIDES					4/2	6/3									2/1	2/1									2/1						■				4/2		2/1										4/2	2/1			2/1	6/3	2/1			4/2		4/2					2/1	4/2	6/3			2/1		2/1	4/2			4/2	2/1			4/2				
White Pine (C)*			2/1			■									4/2	6/3					4/2			2/1								■					2/1						■	■				4/2			6/3		2/1																			6/3		2/1								
BRITISH METALS			2/1	2/1	2/1	▨			2/1	2/1	▨	▨		2/1		▨			2/1					2/1					2/1				■			2/1	2/1					2/1	2/1				2/1			2/1	▨	▨			2/1			2/1									2/1		2/1							▨		2/1		■	■	■
Bancroft (C)									▨	▨																								■		■		■	■	■																												■															
Can. Copper Ref. (C)*		8/1	2/1		■	4/2					4/2			6/3	2/1	23/9			6/3												4/2				■												29/8			6/3		4/2	5/4	5/2	6/3	2/1		■					■	■	■	■	■	■	■	■		10/5			4/2	3/1						
Hudson Bay (C)*					10/5	6/3			3/1					2/1	2/1	▨			2/1						10/2								2/1	■		■		■	■	■		4/2					2/1	2/1		2/1	▨	6/3	4/2	5/10	2/1	2/1	2/1	10/5					■	■	■	■	■	■	■	■		2/1		4/2		2/1		10/5				
Kilembe (C)					2/1	2/1																										2/1	2/1					■				2/1	2/1		2/1			■					2/1		4/2			2/1	2/1							8/4			2/1	2/1			2/1		■	4/2			2/1				
Nchanga (C)									▨	▨																								■		■		■	■	■																												■															
Rhodesia Copper Ref. (C)									▨	▨																								■		■		■	■	■																												■															
Rhokana (C)							■		■																								■		■		■	■	■																												■															
CALUMET & HECLA					4/2				2/1		4/2			3/1	2/1	4/2	2/1		3/1						8/3												2/1				■	4/2	2/1					2/1		3/1	4/2		2/1	4/2	2/1	12/6	▨	4/2							2/1	8/3		4/2			2/1				2/1	4/2		4/2				

Table 14 -- Continued

	ADOLPH LEWISOHN	Tennessee (S)	Anaconda (C)*	Inspiration (C)'	Phelps Dodge (C)'	AMERICAN METAL CLIMAX	Chibuluma (s)	Mazapil (S)	Mufilira (S)	Ndola (S)	O'Okiep (S)	Roan Antelope (S)	Tsumeb (S)	Am. Smelt. & Ref. (C)*	Cyprus (C)	International Nickel (C)*	Pima (C)	Soc. Gen. Met. de Hoboken (C)	AM. SMELT. & REF.'	Bagdad (C)
CERRO		2/1	8/4		8/4	■			4/1		13/4	4/2		24/8	2/1	23/10	2/1		24/8	
COPPER RANGE					4/2	■			4/2		4/2				2/1					
White Pine (S)*			2/1			■									4/2	6/3				
DUVAL																				
Peko Mines (C)																				
FALCONBRIDGE		4/2	2/1	2/1	4/2	2/1			4/2		2/1			2/1		13/5			2/1	
HOWE SOUND			8/4	2/1	18/9	9/4					6/3			4/2	13/5	6/3	2/1		4/2	
Brit. Min. & Smelt. (S)																				
Am. Smelt. & Ref. (C)*			9/4		21/9	8/3			2/1		15/4			■	2/1	18/6			■	
INTERNATIONAL NICKEL *	2/1		12/5		17/9	▨			▨	▨	27/10	6/29		18/6	4/2	■	2/1		18/6	2/1
American Metal Climax (C)*		2/1	4/2		■	■	■	■	■	■	■	■	■	8/3	▨	▨	▨		8/3	
KENNECOTT			9/4	6/3	24/12				2/1					■	2/1	14/6			■	
Braden (S)		4/2	6/3	2/1	8/4	6/3								■	4/2	23/11			■	8/4
Am. Smelt. & Ref. (C)*			9/4		21/9	8/3			2/1		15/4			■	2/1	18/6			■	
MAGMA		6/2	6/3		■	24/7			5/2		■	5/2	■	23/8	■	14/6	■		23/8	2/1
Int. Minerals & Metals (C)						2/1					3/1					2/1	2/1		2/1	
Phelps Dodge (C)*		2/1	20/10	2/1	■	■			6/3		■	4/2	■	21/9	■	17/7	■		21/9	
MITSUBISHI																				
Atlas Cons. Min. & Dev. (C)																				
MOUNT ISA																			■	
Copper Refineries (S)																			■	
NORANDA		4/1			▨											4/2				
Can. Copper Ref. (S)*		8/1	2/1		■	4/2					4/2			6/3	2/1	23/9			6/3	
Gaspe (S)		7/2	8/4		23/6	4/2					2/1			10/5	2/1	30/14			10/5	2/1
Geco (S)			10/4		5/1									19/6	4/2	21/7			19/6	
Hudson Bay (S)*					10/5	6/3			3/1					2/1	2/1	▨			2/1	
Normetal (S)		2/1			9/2	2/1			2/1					2/1	6/3	19/7	2/1		2/1	
Quemont (S)		2/1			7/1	2/1					4/2				2/1	15/5				
Waite Amulet (S)		7/2			10/1										2/1	12/5				
Atlantic Coast (C)				2/1	2/1									6/3	2/1	12/6			6/3	2/1
Campbell Chibougamau (C)		2/1	2/1	2/1	4/2	2/1			4/2	2/1	4/2	2/1		4/1	6/3	15/7			4/1	
Maritimes Mining (C)																				
Opemiska (C)					2/1											6/3				
Patino (C)		8/4			2/1									8/4		2/1				2/1
Sherrit Gordon (C)					■	▨			11/4	2/1	■	9/4	■	11/2	■		■		11/2	
Sullico (C)																				
PHELPS DODGE *		2/1	20/10	2/1	■	■			6/3		■	4/2	■	21/9	■	17/7	■		21/9	
QUINCY																	2/1			
SOC. GEN. de MINERAIS																		■		
Soc. Gen. Met. de Hoboken (S)																		■		
Union Minere																		■		

	Banner (C)	Duval Sulphur & Potash (C)	Lepanto (C)	ANACONDA *	Andes Copper (S)	Chile Exploration (S)	Cobre de Mexico (S)	Cananea (S)	Inspiration (S)	Santiago (S)	APPALACHIAN SULPHIDES	White Pine (C)'	BRITISH METALS	Bancroft (C)	Can. Copper Ref. (C)*	Hudson Bay (C)*	Kilembe (C)	Nchanga (C)	Rhodesia Copper Ref. (C)	Rhokana (C)	CALUMET & HECLA
CERRO	▨			8/4									2/1			4/2	2/1				4/2
COPPER RANGE					9/2							■	2/1								2/1
White Pine (S)*	4/2			2/1								■					2/1				
DUVAL																					
Peko Mines (C)																					
FALCONBRIDGE	4/2			2/1	8/1				2/1		4/2		2/1		29/8	2/1	■				
HOWE SOUND				8/4	4/2				2/1		2/1	4/2				2/1					2/1
Brit. Min. & Smelt. (S)																					
Am. Smelt. & Ref. (C)*	4/2			9/4	4/2	2/1		2/1					2/1								3/2
INTERNATIONAL NICKEL *	6/3			12/5	17/5			5/2			2/1	6/3	▨		23/9	▨					4/2
American Metal Climax (C)*				2/1	17/3							2/1	▨		4/2	6/3	2/1				
KENNECOTT	4/2			9/4	4/2	2/1		2/1	6/3	2/1	2/1	2/1			5/2	4/2					2/1
Braden (S)	2/1			6/3					2/1						5/2	10/5	4/2				4/2
Am. Smelt. & Ref. (C)*	4/2			9/4	4/2	2/1		2/1					2/1		6/3	2/1					3/1
MAGMA	2/1			6/3							4/2				2/1	2/1					12/6
Int. Minerals & Metals (C)	2/1															2/1	2/1				
Phelps Dodge (C)*	2/1			20/10	8/1				2/1				2/1		■	10/5	2/1				4/2
MITSUBISHI																					
Atlas Cons. Min. & Dev. (C)																					
MOUNT ISA																					
Copper Refineries (S)																					
NORANDA	2/1										2/1				■	■					
Can. Copper Ref. (S)*				2/1							4/2				■	■					
Gaspe (S)	4/2			8/4							6/3				■	■	8/4				2/1
Geco (S)	10/4			10/4											■	■					8/3
Hudson Bay (S)*					10/2								2/1	■	■	■		■	■	■	
Normetal (S)	2/1										2/1				■	■		2/1			4/2
Quemont (S)													2/1		■	■		2/1			
Waite Amulet (S)											2/1				■	■					
Atlantic Coast (C)									2/1		2/1										2/1
Campbell Chibougamau (C)	2/1			2/1	4/2			2/1	2/1				6/3		10/5	2/1	2/1				
Maritimes Mining (C)																					
Opemiska (C)	2/1										4/2		2/1			4/2	■				
Patino (C)	2/1										2/1						4/2				2/1
Sherrit Gordon (C)	2/1												▨		3/1	2/1					4/2
Sullico (C)																					
PHELPS DODGE *	2/1			20/10	8/1				2/1		4/2		2/1		■	10/5	2/1				4/2
QUINCY					4/2																
SOC. GEN. de MINERAIS													■								
Soc. Gen. Met. de Hoboken (S)													■								
Union Minere													■								

	CERRO	COPPER RANGE	White Pine (S)*	DUVAL	Peko Mines (C)	FALCONBRIDGE	HOWE SOUND	Brit. Min. & Smelt. (S)	Am. Smelt. & Ref. (C)*	INTERNATIONAL NICKEL *	American Metal Climax (C)*	KENNECOTT	Braden (S)	Am. Smelt. & Ref. (C)*	MAGMA	Int. Minerals & Metals (C)	Phelps Dodge (C)*	MITSUBISHI	Atlas Cons. Min. & Dev. (C)	MOUNT ISA	Copper Refineries (S)
CERRO	■	2/1					16/8		24/8	23/10	■	2/1		24/8	▨	4/2	8/4				
COPPER RANGE	2/1	■	■			2/1	2/1						2/1				4/2				
White Pine (S)*		■	■				4/2			6/3		2/1									
DUVAL				■																	
Peko Mines (C)					■																
FALCONBRIDGE		2/1				■	2/1		2/1	13/5	2/1	8/3	10/4	2/1	2/1		4/2				
HOWE SOUND	16/8	2/1	4/2			2/1	■	■	4/2	13/5	9/4	8/4	14/7	4/2	16/7	6/3	18/9				
Brit. Min. & Smelt. (S)							■	■													
Am. Smelt. & Ref. (C)*	24/8					2/1	4/2		■	18/6	8/3	■	■	■	23/8	2/1	21/9			■	■
INTERNATIONAL NICKEL *	23/10		6/3			13/5	12/5		18/6	■	▨	14/6	23/11	18/6	14/6	2/1	17/7				
American Metal Climax (C)*	■		2/1			2/1	9/4		8/3	▨	■		6/3	8/3	24/7	2/1	■				
KENNECOTT		2/1	2/1			8/3	8/4		■	14/6		■	■	■	2/1	2/1	24/12				
Braden (S)		2/1				10/4	14/7		■	23/11	6/3	■	■	■			8/4				
Am. Smelt. & Ref. (C)*	24/8					2/1	4/2		■	18/6	8/3	■	■	■	23/8	2/1	21/9				
MAGMA		4/2				2/1	16/7		23/8	14/6	24/7	2/1		23/8	■		■				
Int. Minerals & Metals (C)	4/2						6/3		2/1	2/1	2/1			2/1		■					
Phelps Dodge (C)*	8/4					4/2	18/9		21/9	17/7	■	24/12	8/4	21/9	19/8		■				
MITSUBISHI																		■			
Atlas Cons. Min. & Dev. (C)																			■		
MOUNT ISA									■											■	■
Copper Refineries (S)									■											■	■
NORANDA						9/4				4/2		4/2	6/3								
Can. Copper Ref. (S)*						29/8			6/3	23/9	4/2	5/2	5/2	6/3	2/1		■				
Gaspe (S)	4/2	8/4				33/12	8/4		10/5	30/16	4/2	11/5	5/2	10/5	2/1		23/6				
Geco (S)	4/2	4/2				6/2	17/6		19/6	21/9		5/2	2/1	19/6			5/1				
Hudson Bay (S)*	4/2					2/1	2/1		2/1	▨	6/3	4/2	10/5	2/1	2/1	2/1	10/5				
Normetal (S)	2/1	2/1				10/3	4/2		2/1	19/7	2/1		2/1	2/1	2/1		9/2				
Quemont (S)		2/1				8/2	2/1			15/5	2/1						7/1				
Waite Amulet (S)						17/5				12/5		5/2	5/2				10/1				
Atlantic Coast (C)	6/3	2/1					6/3		6/3	12/6		2/1		6/3		2/1	2/1				
Campbell Chibougamau (C)		2/1	6/3				2/1		4/1	15/7	2/1	6/3	14/7	4/1	10/5		4/2				
Maritimes Mining (C)															2/1						
Opemiska (C)			2/1			■	4/2			6/3					2/1		2/1				
Patino (C)	6/3	2/1				▨			11/2	2/1			4/2	11/2			2/1				
Sherrit Gordon (C)	12/5					4/2	2/1			▨	▨				■	3/1	■				
Sullico (C)																					
PHELPS DODGE *	8/4	4/2				4/2	18/9		21/9	17/7	■	24/12	8/4	21/9	19/8		■				
QUINCY							2/1						2/1		2/1						
SOC. GEN. de MINERAIS																					
Soc. Gen. Met. de Hoboken (S)																					
Union Minere																					

	NORANDA	Can. Copper Ref. (S)*	Gaspe (S)	Geco (S)	Hudson Bay (S)*	Normetal (S)	Quemont (S)	Waite Amulet (S)	Atlantic Coast (C)	Campbell Chibougamau (C)	Maritimes Mining (C)	Opemiska (C)	Patino (C)	Sherrit Gordon (C)	Sullico (C)	PHELPS DODGE *	QUINCY	SOC. GEN. de MINERAIS	Soc. Gen. Met. de Hoboken (S)	Union Minere
CERRO			4/2	4/2	4/2	2/1			6/3				6/3	12/5		8/4				
COPPER RANGE			8/4	4/2		2/1	2/1		2/1	2/1						4/2				
White Pine (S)*										6/3		2/1								
DUVAL																				
Peko Mines (C)																				
FALCONBRIDGE	9/4	29/8	21/12	6/2	2/1	19/3	8/2	17/5				■	55/25	4/2		4/2				
HOWE SOUND			8/4	17/6	2/1	4/2	2/1		6/3	2/1		4/2	2/1	2/1		18/9	2/1			
Brit. Min. & Smelt. (S)																				
Am. Smelt. & Ref. (C)*			10/5	18/6		2/1			6/3				8/4	4/2		21/9				
INTERNATIONAL NICKEL *	4/2	23/9	30/14	21/7	▨	19/7	15/5	12/5	12/6	15/7		6/3	2/1	▨		17/7				
American Metal Climax (C)*		4/2	4/2		6/3	2/1	2/1			2/1				▨		■				
KENNECOTT	4/2	5/2	11/5	5/2	4/2			5/2	2/1	6/3			6/3			24/12				
Braden (S)	6/3	5/2	5/2	2/1	10/5	2/1		5/2		14/7			4/2			8/4	2/1			
Am. Smelt. & Ref. (C)*		6/3	10/5	19/6	2/1	2/1			6/3	4/1			8/4	11/2		21/9				
MAGMA		2/1	2/1		2/1	2/1			2/1	10/5		2/1		■		■	2/1			
Int. Minerals & Metals (C)					2/1									3/1						
Phelps Dodge (C)*		■	23/5	5/1	10/5	9/2	7/1	10/1		4/2		2/1	2/1	■		■				
MITSUBISHI																				
Atlas Cons. Min. & Dev. (C)																				
MOUNT ISA																				
Copper Refineries (S)																				
NORANDA	■	■	■	■	■	■	■	■								▨				
Can. Copper Ref. (S)*	■	■	■	■	■	■	■	■		10/5			4/2	3/1		■				
Gaspe (S)	■	■	■	■	■	■	■	■		18/9		2/1	4/2	3/1		23/6				
Geco (S)	■	■	■	■	■	■	■	■		8/3		2/1				5/1	2/1			
Hudson Bay (S)*	■	■	■	■	■	■	■	■		2/1		4/2		2/1		10/5				
Normetal (S)	■	■	■	■	■	■	■	■		8/4		8/4	2/1			9/2	2/1			
Quemont (S)	■	■	■	■	■	■	■	■		4/2			2/1			7/1				
Waite Amulet (S)	■	■	■	■	■	■	■	■		2/1		2/1	2/1			10/1				
Atlantic Coast (C)									■	2/1	▨					2/1	2/1			
Campbell Chibougamau (C)		10/5	18/9	8/3	2/1	8/4	4/2	2/1	2/1	■			2/1			4/2				
Maritimes Mining (C)								▨			■									
Opemiska (C)			2/1	2/1	4/2							■				2/1				
Patino (C)		4/2	4/2			2/1	2/1	2/1		2/1			■	2/1		2/1				
Sherrit Gordon (C)		3/1	3/1		2/1								2/1	■		■				
Sullico (C)															■					
PHELPS DODGE *	▨	■	23/5	5/1	10/5	9/2	7/1	10/1		4/2		2/1	2/1	■		■				
QUINCY				2/1		2/1			2/1								■			
SOC. GEN. de MINERAIS																		■	■	■
Soc. Gen. Met. de Hoboken (S)																		■	■	■
Union Minere																		■	■	■

Measuring the Interconnections

Tables 12, 13, and 14 represent a means of displaying and measuring the horizontal interconnections that existed in the copper industry in 1962. Table 12 portrays ownership and joint membership interconnections; Table 13 portrays ownership, joint membership, and direct interlocking directorates interconnections; and Table 14 portrays all four types of interconnections, including indirect interlocking directorates.

Vertically integrated groups are separated by the heavy horizontal and vertical lines. The selling firm in each group is capitalized. Firms in the group having ownership connections with the selling firm are listed alphabetically after the selling firm and identified with an (S) following their name. Firms in the group having contractual relationships with the selling firm are listed alphabetically following the ownership firms and are identified with a (C) following their name. Each vertical group in the diagonal summarizes the information from Chapter III.

Ownership interconnections are represented by a blackened square. Firms interconnecting groups by holding joint membership are identified with an asterisk following their names.

Joint membership in two or more vertically integrated groups can be seen in Tables 12, 13, and 14. For easier comprehension, these interconnections have been

displayed in Table 15. Here it can be seen that 10 firms of the 69 in the study interconnect two or more groups by joint membership in two or more groups. In fact, joint membership accounts for a total of 24 interconnections between groups.

Table 15. Firms belonging to two or more vertically integrated groups

Firm	Groups Interconnected by the Firm
Anaconda	Adolph Lewisohn Anaconda
Inspiration	Adolph Lewisohn Anaconda
Phelps Dodge	Adolph Lewisohn Magma Phelps Dodge
American Metal Climax	American Metal Climax International Nickel
International Nickel	American Metal Climax International Nickel
Soc. Gen. Metal. de Hoboken	American Metal Climax Soc. Gen. des Minerais
American Smelting & Refining	American Metal Climax American Smelting & Refining Howe Sound Kennecott
White Pine	Appalachian Sulphides Copper Range
Canadian Copper Refiners	British Metal Noranda
Hudson Bay	British Metal Noranda

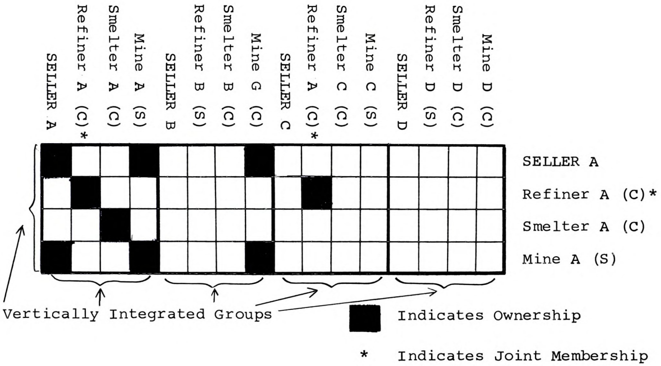
Reading the Tables

Figures 6, 7, and 8 are samples of the matrices found in Tables 12, 13, and 14, respectively. These were designed to help the reader better understand the larger tables.

Figure 6, representing Table 12, shows vertically integrated groups interconnected by ownership and joint membership. It can be determined, then, that Seller A and Mine B are interconnected by ownership. Also, Mine A and Mine B are similarly interconnected. Hence, Group A and Group B are said to be interconnected by ownership. Further, Group A and Group C are interconnected by the joint membership of Refiner A.

Vertically integrated groups interconnected by direct interlocking directorates are exhibited in Figure 7. The direct interlocks between Group D and Groups E and G are not counted as direct interlocking interconnections because the ownership interconnections supersede them. Group D and Group F are said to be interconnected by direct interlocks because of the three common directors shared by Seller F and Seller D and Refiner D. Further, Seller D and Refiner D each share one common director with Refiner F, Smelter F, and Mine F.

Vertically integrated groups interconnected by indirect interlocking directorates are exhibited in Figure 8.



	SELLER A	Refiner A (C)*	Smelter A (C)	Mine A (S)	SELLER B	Refiner B (S)	Smelter B (C)	Mine G (C)	SELLER C	Refiner A (C)*	Smelter C (C)	Mine C (S)	SELLER D	Refiner D (S)	Smelter D (C)	Mine D (C)
SELLER A	■			■				■								
Refiner A (C)*		■								■						
Smelter A (C)			■													
Mine A (S)	■			■				■								

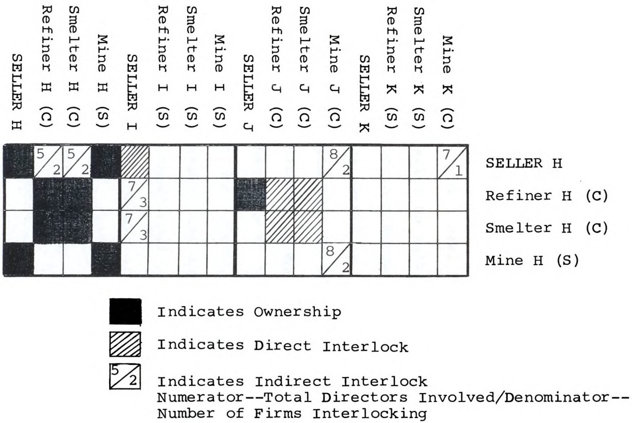
Figure 6. Sample matrix showing vertically integrated groups interconnected by ownership and joint membership.

	SELLER D	Refiner D (S)	Smelter D (C)	Mine D (C)	SELLER E	Refiner E (C)	Smelter E (C)	Mine E (S)	SELLER F	Refiner F (S)	Smelter F (S)	Mine F (S)	SELLER G	Refiner G (C)	Smelter G (C)	Mine G (S)
SELLER D	■	■	2						3	1	1	1				
Refiner D (S)	■	■	1			1	1		3	1	1	1		1		
Smelter D (C)	2	1	■												■	
Mine D (C)				■	■			■								

■ Indicates Ownership

2 Indicates Number of Common Directors

Figure 7. Sample matrix showing vertically integrated groups interconnected by ownership and direct interlocking directorates.



	SELLER H	Refiner H (C)	Smelter H (C)	Mine H (S)	SELLER I	Refiner I (S)	Smelter I (S)	Mine I (S)	SELLER J	Refiner J (C)	Smelter J (C)	Mine J (C)	SELLER K	Refiner K (S)	Smelter K (S)	Mine K (C)
SELLER H	■	5/2	5/2	■	▨							8/2				7/1
Refiner H (C)		■	■		7/3				■	▨	▨					
Smelter H (C)		■	■		7/3					▨	▨					
Mine H (S)	■			■								8/2				

■ Indicates Ownership

▨ Indicates Direct Interlock

5/2 Indicates Indirect Interlock
Numerator--Total Directors Involved/Denominator--
Number of Firms Interlocking

Figure 8. Sample matrix showing vertically integrated groups interconnected by ownership and direct and indirect interlocking directorates.

Only the interconnection of Group H and Group K is counted as an indirect interlock. Seller H and Mine K being indirectly interlocked with a total of seven directors from the two firms meeting on an outside board. Group H and Group I are interconnected by direct interlock and Group H and Group J are interconnected by ownership.

The Density Measure

Although one can examine the three tables and get some idea of the amount of interconnections between groups, one lacks a yardstick for a real measure. On the other hand, if one views these tables as matrices showing all possible horizontal interconnections between groups, then one could use the density of the matrix as an effective measure.

Keeping in mind that it is the horizontal interconnections between vertically integrated groups that one wishes to measure, then each of the matrices contains 441 possible interconnections. Given the construction of the matrices, one would expect the diagonal to be filled. It represents the interconnections of each group with itself. Therefore, by removing the diagonal, the matrix contains 420 possible interconnections and the density can be expressed as a fraction or percent of 420. On the other hand, if one were interested in examining the interconnections of a single group with the rest of the groups, the density would be measured a fraction of 20.

Analyzing the Interconnections

The discussion of the horizontal interconnections between groups will proceed in the following manner. First, the horizontal interconnections for each of the vertically integrated groups will be presented. Second, the density of the entire matrix will be discussed so that the significance of each type of interconnection is exposed.

The Adolph Lewisohn Group

Adolph Lewisohn interconnects with the following groups in the following manner:

Groups Interconnected	Interconnection
American Metal Climax	Ownership
British Metal Corp.	Ownership
International Nickel	Ownership
Noranda	Ownership
Anaconda	Joint Membership
Magma	Joint Membership
Phelps Dodge	Joint Membership
Amer. Smelting & Refining	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Cerro	Indirect Interlock
Falconbridge	Indirect Interlock
Howe Sound	Indirect Interlock
Kennecott	Indirect Interlock

The ownership density is 4/20 or 20 percent and, when joint memberships are added, density is 7/20 or 35 percent. Finally, when indirect interlocks are added, the density is increased to 14/20 or 70 percent. There were no direct interlock interconnections.

The American Metal Climax Group

American Metal Climax is interconnected with the following groups in the following manner:

Groups Interconnected	Interconnection
Adolph Lewisohn	Ownership
Appalachian Sulphides	Ownership
British Metal Corp.	Ownership
Cerro	Ownership
Copper Range	Ownership
Magma	Ownership
Noranda	Ownership
Phelps Dodge	Ownership
Amer. Smelting & Refining	Joint Membership
Howe Sound	Joint Membership
International Nickel	Joint Membership
Kennecott	Joint Membership
Soc. Gen. des Minerais	Joint Membership
Anaconda	Indirect Interlock
Calumet Hecla	Indirect Interlock
Falconbridge	Indirect Interlock
Quincy	Indirect Interlock

The ownership density is 8/20 or 40 percent and, when joint memberships are added, density is 13/20 or 65 percent. Finally, when indirect interlock interconnections are added, density is increased to 17/20 or 85 percent. There were no direct interlock interconnections.

The American Smelting & Refining Group

American Smelting & Refining is interconnected to the following groups in the following manner:

Groups Interconnected	Interconnection
Kennecott	Ownership
Mount Isa	Ownership
American Metal Climax	Joint Membership
Howe Sound	Joint Membership
Cerro	Direct Interlock
Adolph Lewisohn	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
British Metal Corp.	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Copper Range	Indirect Interlock
Falconbridge	Indirect Interlock
International Nickel	Indirect Interlock
Magma	Indirect Interlock
Noranda	Indirect Interlock
Phelps Dodge	Indirect Interlock

The ownership density is 2/20 or 10 percent and, when joint memberships are added, density is 4/20 or 20 percent. When direct interlock interconnections are added, density is increased to 5/20 or 25 percent. Finally, when indirect interlock interconnections are added, density is increased to 16/20 or 80 percent.

The Anaconda Group

Anaconda is interconnected to the following groups in the following manner:

Groups Interconnected	Interconnection
Adolph Lewisohn	Joint Membership
American Metal Climax	Indirect Interlock
Amer. Smelting & Refining	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
British Metal Corp.	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Cerro	Indirect Interlock
Copper Range	Indirect Interlock
Falconbridge	Indirect Interlock
Howe Sound	Indirect Interlock
International Nickel	Indirect Interlock

Groups Interconnected	Interconnection
Kennecott	Indirect Interlock
Magma	Indirect Interlock
Noranda	Indirect Interlock
Phelps Dodge	Indirect Interlock
Quincy	Indirect Interlock

The joint membership density is 1/20 or 5 percent and, when indirect interlock interconnections are added, density is increased to 16/20 or 80 percent. There were no ownership or direct interlock interconnections.

The Appalachian Sulphide Group

Appalachian Sulphide is interconnected to the following groups in the following manner:

Groups Interconnected	Interconnection
American Metal Climax	Ownership
Copper Range	Joint Membership
Adolph Lewisohn	Indirect Interlock
Amer. Smelting & Refining	Indirect Interlock
Anaconda	Indirect Interlock
British Metals	Indirect Interlock
Falconbridge	Indirect Interlock
Howe Sound	Indirect Interlock
International Nickel	Indirect Interlock
Kennecott	Indirect Interlock
Magma	Indirect Interlock
Noranda	Indirect Interlock
Phelps Dodge	Indirect Interlock

The ownership density is 1/20 or 5 percent and when joint membership interconnection is added, density is increased to 2/20 or 10 percent. Finally, when indirect interlock interconnections are added, density is increased to 13/20 or 65 percent. There were no direct interlock interconnections.

The British Metal Group

British Metal Corporation interconnects the following groups in the following manner:

Groups Interconnected	Interconnection
Adolph Lewisohn	Ownership
American Metal Climax	Ownership
Falconbridge	Ownership
Magma	Ownership
Soc. Gen. des Minerais	Ownership
Noranda	Joint Membership
International Nickel	Direct Interlock
Amer. Smelting & Refining	Indirect Interlock
Anaconda	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Copper Range	Indirect Interlock
Howe Sound	Indirect Interlock
Kennecott	Indirect Interlock
Phelps Dodge	Indirect Interlock

The ownership density is 5/20 or 25 percent and, when joint membership is added, density is 6/20 or 30 percent. When direct interlock interconnections are added, density is increased to 7/20 or 35 percent. Finally, when indirect interlock interconnections are added, density is increased to 16/20 or 80 percent.

The Calumet & Hecla Group

Calumet & Hecla is interconnected to the following groups in the following manner:

Groups Interconnected	Interconnection
Magma	Direct Interlock
Adolph Lewisohn	Indirect Interlock
American Metal Climax	Indirect Interlock
Amer. Smelting & Refining	Indirect Interlock
Anaconda	Indirect Interlock
British Metal Corp.	Indirect Interlock
Cerro	Indirect Interlock
Copper Range	Indirect Interlock
Howe Sound	Indirect Interlock
International Nickel	Indirect Interlock
Kennecott	Indirect Interlock
Noranda	Indirect Interlock
Phelps Dodge	Indirect Interlock

The ownership and joint membership density is 0/20 or 0 percent indicating no ownership or joint membership interconnections. When direct interlock interconnections are added, density is increased to 1/20 or 5 percent and, when indirect interlock interconnections are added, density is increased to 13/20 or 65 percent.

The Cerro Group

Cerro is interconnected to the following groups in the following manner:

Groups Interconnected	Interconnection
American Metal Climax	Ownership
International Nickel	Ownership
Amer. Smelting & Refining	Direct Interlock
Magma	Direct Interlock
Adolph Lewisohn	Indirect Interlock
Anaconda	Indirect Interlock
British Metal Corp	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Copper Range	Indirect Interlock
Howe Sound	Indirect Interlock
Kennecott	Indirect Interlock
Noranda	Indirect Interlock
Phelps Dodge	Indirect Interlock

The ownership density is 1/20 or 5 percent and, when joint membership is added, density is 2/20 or 10 percent. When indirect interlock interconnections are added, density is increased to 15/20 or 75 percent. There are no direct interlock interconnections.

The Duval Group[2]

There were no interconnections of any kind with any group. This is a Japanese and Australian group with annual production of 8,000 tons of copper or less than 2/10 of 1 percent of the world copper production.

The Falconbridge Group

Falconbridge is interconnected with the following groups in the following manner:

Groups Interconnected	Interconnections
British Metal Corp.	Ownership
Noranda	Ownership
Adolph Lewisohn	Indirect Interlock
American Metal Climax	Indirect Interlock
Amer. Smelting & Refining	Indirect Interlock
Anaconda	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
Copper Range	Indirect Interlock
Howe Sound	Indirect Interlock
International Nickel	Indirect Interlock
Kennecott	Indirect Interlock
Magma	Indirect Interlock
Phelps Dodge	Indirect Interlock

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[2] Duval, Mitsubishi, Mount Isa, and Quicny, all relatively small producers, were included in this study because they were listed by the American Bureau of Metal Statistics.

The ownership density is 2/20 or 10 percent and, when indirect interlock interconnections are added, density is increased to 13/20 or 65 percent. There were no direct interlock or joint membership interconnections.

The Howe Sound Group

Howe Sound is interconnected with the following groups in the following manner:

Groups Interconnected	Interconnection
Mount Isa	Ownership
American Metal Climax	Joint Membership
Amer. Smelting & Refining	Joint Membership
Kennecott	Joint Membership
Adolph Lewisohn	Indirect Interlock
Anaconda	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
British Metal Corp.	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
British Metal Corp.	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Cerro	Indirect Interlock
Copper Range	Indirect Interlock
Falconbridge	Indirect Interlock
International Nickel	Indirect Interlock
Magma	Indirect Interlock
Noranda	Indirect Interlock
Phelps Dodge	Indirect Interlock
Quincy	Indirect Interlock

The ownership density is 1/20 or 5 percent and, when joint membership is added, density is 4/20 or 20 percent. When indirect interlock interconnections are added, density is increased to 17/20 or 85 percent. There were no direct interlock interconnections.

The International Nickel Group

International Nickel is interconnected with the following groups in the following manner:

Groups Interconnected	Interconnection
Adolph Lewisohn	Ownership
Cerro	Ownership
Magma	Ownership
Phelps Dodge	Ownership
American Metal Climax	Joint Membership
Amer. Smelting & Refining	Direct Interlock
British Metal Corp.	Direct Interlock
Noranda	Direct Interlock
Anaconda	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Copper Range	Indirect Interlock
Falconbridge	Indirect Interlock
Howe Sound	Indirect Interlock
Kennecott	Indirect Interlock

The ownership density is 4/20 or 20 percent and, when joint membership is added, density is 5/20 or 25 percent. When direct interlock interconnections are added, density is increased to 8/20 or 40 percent. Finally, when indirect interlock interconnections are added, density is increased to 15/20 or 75 percent.

The Kennecott Group

Kennecott is interconnected with the following groups in the following manner:

Groups Interconnected	Interconnection
Amer. Smelting & Refining	Ownership
American Metal Climax	Joint Membership
Howe Sound	Joint Membership
Adolph Lewisohn	Indirect Interlock
Anaconda	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
British Metal Corp.	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Cerro	Indirect Interlock
Copper Range	Indirect Interlock
Falconbridge	Indirect Interlock
International Nickel	Indirect Interlock
Magma	Indirect Interlock
Noranda	Indirect Interlock
Phelps Dodge	Indirect Interlock
Quincy	Indirect Interlock

The ownership density is 1/20 or 15 percent and, when joint membership is added, density is 3/20 or 15 percent. When indirect interlock interconnections are added, density is increased to 16/20 or 80 percent. There were no direct interlock interconnections.

The Magma Group

Magma is interconnected with the following groups in the following manner:

Groups Interconnected	Interconnection
American Metal Climax	Ownership
British Metal	Ownership
International Nickel	Ownership
Noranda	Ownership
Phelps Dodge	Ownership
Adolph Lewisohn	Joint Membership
Calumet & Hecla	Direct Interlock
Cerro	Direct Interlock
Amer. Smelting & Refining	Indirect Interlock
Anaconda	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
Copper Range	Indirect Interlock

Groups Interconnected	Interconnection
Falconbridge	Indirect Interlock
Howe Sound	Indirect Interlock
Kennecott	Indirect Interlock
Quincy	Indirect Interlock

The ownership density is 5/20 or 25 percent and, when joint membership is added, density is 6/20 or 20 percent. When direct interlock interconnections are added, density is increased to 8/20 or 40 percent. Finally, when indirect interlock interconnections are added, density is increased to 16/20 or 80 percent.

The Mitsubishi Group

Mitsubishi has no interconnections with any other group. This is a Japanese and Phillipine group producing 25,000 tons of copper annually or approximately 1/2 of 1 percent of the world production.

The Mount Isa Group

Mount Isa is interconnected with the following groups in the following manner:

Groups Interconnected	Interconnection
Amer. Smelting & Refining	Ownership
Howe Sound	Ownership

The ownership density is 2/20 or 10 percent. There are not joint membership, direct or indirect interlock interconnections.

The Noranda Group

Noranda is interconnected with the following groups in the following manner:

Groups Interconnected	Interconnection
Adolph Lewisohn	Ownership
American Metal Climax	Ownership
Falconbridge	Ownership
Magma	Ownership
Phelps Dodge	Ownership
British Metal	Joint Membership
International Nickel	Direct Interlock
Amer. Smelting & Refining	Indirect Interlock
Anaconda	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Cerro	Indirect Interlock
Copper Range	Indirect Interlock
Howe Sound	Indirect Interlock
Kennecott	Indirect Interlock
Quincy	Indirect Interlock

The ownership density is 5/20 or 25 percent and, when joint membership is added, density is 6/20 or 30 percent. When direct interlock interconnections are counted, density is increased to 7/20 or 35 percent. Finally, when indirect interlock interconnections are added, density is increased to 16/20 or 80 percent.

The Phelps Dodge Group

Phelps Dodge is interconnected with the following groups in the following manner:

Groups Interconnected	Interconnection
American Metal Climax	Ownership
British Metal Corp.	Ownership
International Nickel	Ownership
Magma	Ownership
Adolph Lewisohn	Joint Membership
Amer. Smelting & Refining	Indirect Interlock
Anaconda	Indirect Interlock
Appalachian Sulphides	Indirect Interlock
Calumet & Hecla	Indirect Interlock
Cerro	Indirect Interlock
Copper Range	Indirect Interlock
Falconbridge	Indirect Interlock
Howe Sound	Indirect Interlock
Kennecott	Indirect Interlock

The ownership density is 5/20 or 25 percent and, when joint membership is added, density is 6/20 or 30 percent. When indirect interlock interconnections are added, density is increased to 15/20 or 75 percent. There were no direct interlock interconnections.

The Quincy Group

Quincy is interconnected with the following groups in the following manner.

Groups Interconnected	Interconnections
American Metal Climax	Indirect Interlock
Anaconda	Indirect Interlock
Howe Sound	Indirect Interlock
Kennecott	Indirect Interlock
Magma	Indirect Interlock
Noranda	Indirect Interlock

The ownership and joint membership density is 0/20 or 0 percent indicating no ownership or joing membership interconnections. Also there were no direct interlock

interconnections. When indirect interlock interconnections are added, density is increased to 6/20 or 30 percent.

The Societe General des Minerais Group

Societe General des Minerais is interconnected by ownership to British Metal Corporation and by joint membership to American Metal Climax. It has no other interconnections.

Total Density of the Matrices

Examining the ownership matrix, one finds that the density is 48/420 or 11.6 percent. There are 48 ownership interconnections between groups, not explained by the diagonal or, one could say that the average group has 2.3 ownership interconnections. There are 24 joint membership interconnections. The average group had 1.1 joint membership interconnections.

The direct interlocking directorate matrix has a density of 83/420 or 19.7 percent. There are 11 cases of direct interlock interconnections not explained by ownership. The average for each group is 0.5 direct interlocks. The indirect interlocking matrix has a density of 250/420 or 60 percent. In this matrix there are 167 cases of indirect interlock interconnections not explained by ownership or direct interlocks or an average of 8 for each group.

Effect of Contractual Relationships

Some of the horizontal interconnections among the vertically integrated groups might not exist if all vertically integrated were based strictly upon ownership. The firms processing copper on contract were the basis for the 24 joint membership interconnections. Further, these firms also were the basis for 31 other interconnections, 6 ownership and 25 indirect interlocks. These interconnections can be found in Table 16.

Summary and Conclusions

The copper industry has what appears to be a strong horizontal structure. Approximately 60 percent of all possible points of horizontal interconnection show some form of interconnection existing. The most common form of interconnection is indirect interlocking directorates. Ownership is second, joint membership is third, and direct interlock is fourth.

The next chapter will summarize the entire study and attempt to draw conclusions about the vertical and horizontal structure of the copper industry.

Table 16. Horizontal interconnections based upon contracts for processing copper[a]

Group	Groups Interconnected	
Adolph Lewisohn	Amer. Smelting & Refining Appalachian Sulphides British Metals Calumet and Hecla Copper Range Howe Sound	(I (I (O (I (I (I
American Metal Climax	Quincy	(I
Amer. Smelting & Refining	Adolph Lewisohn Appalachian Sulphides Copper Range	(I (I (I
Appalachian Sulphides	Adolph Lewisohn Amer. Smelting & Refining British Metals	(I (I (I
British Metals	Adolph Lewisohn Appalachian Sulphides Calumet and Hecla Howe Sound Kennecott Magma	(O (I (I (I (I (O
Calumet and Hecla	Adolph Lewisohn British Metals	(I (I
Copper Range	Adolph Lewisohn Amer. Smelting & Refining Magma	(I (I (I
Howe Sound	Adolph Lewisohn British Metals Mount Isa	(I (I (O
Kennecott	British Metals	(I
Magma	British Metals	(O
Mount Isa	Howe Sound	(O
Quincy	American Metal Climax	(I

[a] Does not include joint memberships (see Table 15).

[b] (I) indicates indirect interlocking interconnecti
(O) indicates ownership interconnection.

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter will summarize the study and present a discussion of the potential implications of the findings.

Purpose of the Study

The purpose of this study was to examine the vertical and horizontal structures of the copper industry in 1962. Particular emphasis was to be placed upon determining the interconnections attributable to each of the following types: ownership, joint membership, contract, and direct and indirect interlocking directorates.

Vertical and Horizontal Structures Defined

One of the first tasks was to define the vertical and horizontal structures. The vertical structure was defined as the interconnections existing between members of a vertically integrated group and the selling firm of the group. A vertically integrated group was defined as a group of firms all processing copper for a single selling firm. The selling firm was also a member of the group. The horizontal structure was defined as the interconnections existing among the vertically integrated groups.

Hypothesis to Be Tested

The hypothesis to be tested in this study related to the interconnections that formed the basis for the structure of the copper industry. The hypothesis is stated as follows:

> In the copper industry there exists vertical and horizontal structures consisting of interconnections of ownership, joint membership in two or more vertically integrated groups, contractual relationships, and direct and indirect interlocking directorates.

Methodology

The problems encountered in studying the vertical and horizontal structures of the copper industry were:

1. determining where interconnections exist.
2. determining whether the interconnection is vertical or horizontal.
3. classifying the interconnection by type.

The first problem, determining the existence of interconnections, was one of collecting, sorting, and tabulating information. A part of this, dealing with direct and indirect interlocking directorates, was computerized because of the vast amount of data to be processed.

Secondly, the 69 firms in the study were found to be organized into 21 vertically integrated groups. This permitted one to determine whether an interconnection between any two firms was vertical or horizontal.

Thirdly, because any two firms might be interconnected by more than one type of interconnection, the types of interconnections were ranked by their potential for control. Therefore, one could classify the interconnection by type even though more than one type existed. These rankings can be seen in Table 17 as follows:

Table 17. Interconnections ranked by potential power of control over interconnected firms

Type of Interconnection	Rank[a]
Horizontal Structure	
Ownership	1
Joint Membership	1
Direct Interlocking Directorate	2
Indirect Interlocking Directorate	3
Vertical Structure	
Ownership	1
Direct Interlocking Directorate	2
Indirect Interlocking Directorate	3
Contractual Relationships	4

[a] Rank depends upon number of directors involved. A contractual relationship may be stronger than either direct or indirect interlocking directorates.

Results of the Study

The vertical structure is interconnected primarily by ownership and contractual relationships. Of the 61 interconnections with the selling firms, 27 are ownership and 34 are contractual. Further, there were five direct and five

indirect interlocking directorates found to exist in the vertical structure.

The horizontal structure is interconnected primarily by indirect interlocking directorates with 167 interconnections. Ownership is the next most common interconnection with 48 interconnections between groups. Joint membership in two or more vertically integrated groups is next in prevalence with 24 interconnections. Direct interlocking directorates are the least most common device with only 11 interconnections. These results are also summarized in Table 18.

Table 18. Summary of interconnections existing in the vertical and horizontal structures

	Net Number of Interconnections[a]	
Type of Interconnection	Vertical Structure	Horizontal Structure
Ownership	21	48
Joint Membership	dna[b]	24
Direct Interlock	5	11
Indirect Interlock	5	167
Contractual Relationship	34	dna[b]

[a] These are net figures. Interconnections ranking high in potential of control superceded all other interconnections; i.e., Firms A and B are connected by both ownership and direct interlocking directorates; only the ownership interconnection is counted.

[b] Did not apply.

Validity of the Hypothesis

The results appear to support the hypothesis. The copper industry is interconnected in the vertical and horizontal structures by ownership, joint membership, contractual relationships, and direct and indirect interlocking directorates.

Implications of the Vertical Structure

More than 90 percent of the free world copper production is produced and sold through 21 vertically integrated groups. Further, these groups are structured either by ownership or by contractual relationships. Because of economies of scale, all units within the groups generally are large and possess large capital investments and fixed costs. Further, because of the high fixed costs, it is reasonable to assume that individual firms desire to band together in such vertically integrated groups to assure themselves of continuity of supplies of raw materials and markets for their products.

Negative implications arise when one considers the potential effects of this vertical structure on new entires into the copper industry. Firms desiring to enter in any stage of the industry, mining, smelting, refining, or selling, might find themselves limited either by sources for raw materials or by markets for their products. Mines need smelters and refiners to process their ore. Smelters and

refiners need ore for processing and sellers for markets for their blister and refined copper. Hence, entry at any single stage requires that certain other copper firms adjust their capacity to accommodate the newcomer. The question arises, will they do it? If the horizontal structure dictates a policy of restriction of output it is not likely that any group will make such an accommodation.

Entry to the industry by a fully integrated firm might also be limited. Capital requirements to open new mines, smelters, and refiners are large due to the need for large scale operations.

Implications of the Horizontal Structure

As previously stated, more than 90 percent of the free world copper is produced and sold through 21 vertically integrated groups. Further, these groups are interconnected in approximately 60 percent of all possible interconnections between groups. On the average, each group is interconnected with 11.9 other groups. A breakdown of these interconnections follows:

Type of Group Interconnection	Average Interconnections
Indirect Interlock	8.0
Ownership	2.3
Joint Membership	1.1
Direct Interlock	0.5
Total	11.9

Implications of the above might lead one to hypothesize some overall design. It is hard to believe that such a structure is accidental. Also, it is equally hard to prove that the structure is anything but accidental. Given such a structure, existing because of accident or design, the implications as to potential effects upon competition are the same.

The structure, considering the worst conditions,[1] provides the basis for interaction and control throughout the industry. Output, pricing policies, and market shares can be planned and coordinated. Further, the structure provides a method for feedback and control of the total structure. In effect, the industry could act as a giant monopoly with marginal, non-integrated firms to give lip service to competition.

At best, the structure provides an excellent device for full information flow throughout the industry. Such information in a system of cooperating oligopolists could be used so that each vertically integrated group could adapt itself to the actions and plans of the other groups. The adaptations would be such that the best interests of all groups is served.

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[1] Worst conditions refer to the state of competition.

Although the implications for competition in the copper industry are negative, there are substitutes for copper which should provide some competitive pressures. Unfortunately, the main substitutes for copper are other non-ferrous metals. Government studies have indicated that strong ties exist among the producers of most non-ferrous metals.[2]

This study, showing the vertical and horizontal structure of the copper industry, has perhaps developed more questions than it has answered. It is hoped that this approach to studying industry structure will be useful to the study of other industries. Further, it is hoped that this study may act as a starting-off place for future studies of the copper industry.

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[2] _Interlocking Directorates_, _op. cit_., pp. 147-175.

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