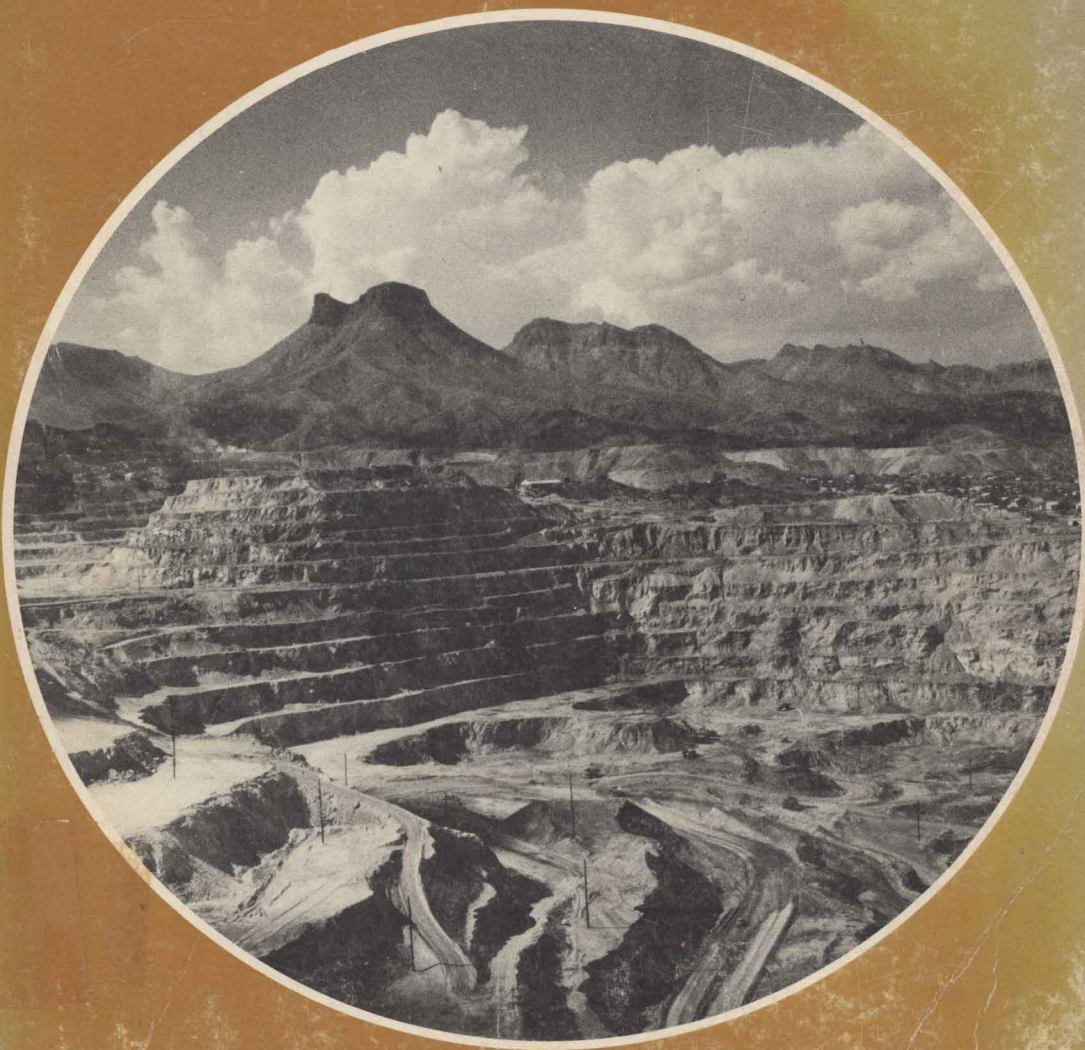


THE WORLD COPPER INDUSTRY

STRUCTURE AND
ECONOMIC ANALYSIS

Raymond F. Mikesell

*A Book from
Resources for the Future*



The World COPPER INDUSTRY

Structure and Economic Analysis

RAYMOND F. MIKESELL

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Preface

THIS BOOK is a survey of the world copper industry and of the problems with which policy makers and students of the industry are currently concerned. My interest in the copper industry arose out of research on foreign investment in minerals, an interest that dates from my association with the President's Materials Policy Commission, as director of the commission's foreign resources division in 1951-52. Hence, readers will find a rather heavy emphasis on foreign investment in mining, especially in the Third World copper producing countries.

Although this book reflects information and suggestions from many individuals, I am solely responsible for all but two of the chapters. Chapter 2, which deals with the physical characteristics of the copper industry, including a description and evaluation of new metallurgical processes, is authored by John W. Whitney who is both a geologist and Ph.D. in mineral economics. Chapter 5, which is authored by Kirkor Bozdogan and Raymond S. Hartman, reflects the work of these economists on an econometric model of the copper industry prepared at Arthur D. Little, Inc. for the U.S. Environmental Protection Agency. This chapter, together with my own chapter 6 on the quantitative analysis of copper supply, is designed to provide the reader with an introduction to, and evaluation of, econometric commodity modeling techniques which have been applied to the copper industry. In preparing chapter 6, I received substantial assistance from Jos Bruggink, now with the Energy Study Center, Petten, the Netherlands.

The decision to undertake this study grew out of conversations with Orris C. Herfindahl and Sam Schurr of Resources for the Future. A large number of individuals have assisted me in dealing with various topics treated in this book. I would like first of all to acknowledge help from Hans Landsberg and John J. Schanz, Jr. of Resources for the Future, who reviewed the initial draft of my manuscript. Comprehensive critical reviews of my manuscript were undertaken at the request of RFF by Wolfgang Gluschke, United Nations Centre for Natural Re-

sources, Energy and Transport; Roger Sedjo of RFF; Simon Strauss, vice chairman of ASARCO; Gerhard Theibach of the World Bank; and John E. Tilton, professor of mineral economics, Pennsylvania State University. The detailed criticisms and suggestions by these reviewers were immensely valuable in preparing the final edition of the manuscript, and although they are in no way responsible for the errors and weaknesses that remain, their comments contributed greatly to improving the quality of this study.

In addition to the assistance from the reviewers, I gained important insights on exploration from Merwin Bernstein and Thomas N. Walthier of St. Joe Minerals. I obtained numerous ideas and encouragement from Charles F. Barber of ASARCO; Walter Chudson of the United Nations; Alun G. Davies of Rio Tinto-Zinc; Ross Garnaut of the Australian National University; Sacha Gueronik and Peter Parkinson of CIPEC; Taylor Ostrander of AMAX; Sir Ronald Prain, formerly Chairman of Roan Selection Trust; Marian Radetzki of the Institute for International Economic Studies (Stockholm); Harold J. Schroeder, U.S. Bureau of Mines; Milton Stern of Kennecott Copper Corporation; Alexander Sutulov, Centro de Investigacion Minera y Metalurgica, Santiago, Chile; Kenji Takeuchi and Benson Varon of the World Bank; George R. Westby, Southern Peru Copper Corporation; Stephen A. Zorn, Commodities Research Unit; and my colleagues at the University of Oregon, Eaton H. Conant and Robert E. Smith.

Research assistance, including preparation of some of the appendixes for this book, was provided by Jos Bruggink and Steve Staloff, former graduate students in economics at the University of Oregon who have since received their doctorates. My wife, Irene, provided constructive criticism and countless hours in reading the manuscript for preliminary editing. Without her patience and encouragement this book could never have been written. Finally, my secretary, Letty Fotta, rendered competent and tireless service beyond what any author has the right to ask.

March 1979

Raymond F. Mikesell
University of Oregon

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Introduction

OVER THE PAST decade, events relating to the world copper industry have generated widespread public interest, and hundreds of books have been written by economists, political scientists, environmentalists, commodity specialists, business executives, geologists, and engineers on topics of general interest concerned with this industry. In recent years more has been written about copper than about any other nonfuel mineral. The reasons are easy to understand. The prices of this important industrial commodity gyrated widely during the 1970s, and fears of inadequate copper supplies in 1973 and early 1974 quickly shifted to concerns about the effects of excessive copper supplies and low prices on employment and the financial welfare of the copper industry in the United States and Canada, and the impact on the economies of the principal copper producing countries in the Third World. Copper smelters constitute a serious environmental problem and current and proposed regulations by the Environmental Protection Agency have generated a heated debate between EPA and the environmentalists on the one hand, and industry spokesmen on the other. Foreign investments by large U.S. and European copper mining companies in Africa and Latin America have been expropriated by the governments of host countries to an extent not equaled for any other industry except petroleum. The justifications for the nationalization of American and European companies in Chile, Peru, Zambia, and Zaire, among others, have been the subject of intense debates among social scientists, politicians, and business leaders the world over. U.S. diplomatic relations with some of these countries have been considerably influenced by the treatment of U.S. investments in the copper industry. The 1978 invasion from Angola of Shaba Province in Zaire might not have generated the same degree of international concern and intervention if it had not threatened the bulk of the copper output from one of the world's leading copper producers. The debate within the United Nations Conference on Trade and Development (UNCTAD) in Geneva over methods for stabilizing the prices of

international commodities has centered in considerable measure on the stabilization of world copper prices. The establishment of the Inter-Governmental Council of Copper Exporting Countries (CIPEC) led to widespread concern in the developed countries that nonfuel mineral producing countries would be able to create cartels with market power similar to that exercised by OPEC. Finally, the U.S. copper industry has been the subject of a number of administration and congressional studies relating to the competitive structure of the industry, the need for import protection, and the creation of a national copper stockpile.

In light of these varied interests centered on copper, it seemed appropriate to write a book which would not simply review the major topics related to copper, but would provide a largely nontechnical basis for understanding them. An effort has been made to integrate the subject matter by showing the relationship between the physical characteristics of the industry and its market and industrial structure. These in turn are essential for understanding several policy issues relating to copper, including: (1) assuring adequate supplies at reasonable prices for meeting future world demand; (2) the role of foreign investment and measures for promoting it; (3) protecting the environment without endangering domestic supplies; (4) maintaining competition and an efficient price system; (5) encouraging resource conservation through recycling; and (6) moderating uneconomic price fluctuations.

Much of the analysis of the copper industry in this book also applies directly to other nonfuel minerals industries. This is particularly the case in the discussion of the economics of mining investment; measures for international price stabilization; foreign investment and its promotion; the economics of exhaustible resources; investment requirements for meeting future demand; and recycling. Even the physical characteristics, industrial structure, and market organization of copper have a great deal in common with such nonfuel minerals as iron ore, lead, zinc, and nickel.

Since this book covers a broad spectrum of disciplines ranging from geology and engineering to the economics of price stabilization and cartels, it is not intended to make an original contribution of interest to specialists in any area of the applied physical or social sciences. Rather, it is designed to acquaint the reader who may not be a specialist in mineral economics, geology, or mine engineering with the physical characteristics of the copper industry; to acquaint the reader who is not a mining company official or commodity specialist with the structure and operation of the world's copper markets; and to provide the reader who is not an econometric commodity model builder with the elements of quantitative analysis of the demand for and supply of copper.

The material in this book is in considerable measure oriented to policy issues rather than to description and theoretical analysis. However, the conclusions summarized in chapter 14 are more in the nature of findings than recommendations for specific policy actions. Special emphasis is given to the following policy issues: (1) the competitiveness of the U.S. copper industry; (2) the adequacy of world copper resources for meeting the long-run requirements of the market economies; (3) the possibilities for modifying sharp fluctuations in copper prices; (4) the likelihood of an effective world copper producers' cartel that would raise prices significantly above long-run equilibrium levels; (5) the outlook for the development of sufficient copper producing capacity for meeting world demand over the next two decades and the measures for assuring an adequate level of capacity; and (6) the role of foreign investment and measures for encouraging it. Our conclusions are broadly optimistic in terms of the long-run ability of the industry to supply world requirements and the feasibility of finding solutions to the industry's problems.

1

Overview

Brief History of Copper

THE DISCOVERY and use of copper dates from prehistoric times when Stone Age people in the Mediterranean beat the red stones found on the island of Cyprus (from which copper gets its name) into implements. Copper was first used in its pure, natural form without benefit of metallurgy, just as it was used by the native Africans who were visited by Dr. David Livingston,¹ and by the American Indians in the Lake Superior region long before the arrival of the Europeans. Some of the ancient copper ore bodies, such as those in the Timna Valley in Israel—believed to have been the site of King Solomon's mines—have been worked intermittently to the present day. The famous Cyprus mines which supplied the Phoenicians and the Greeks and later the Romans were rediscovered by the American engineer-geologist, D. A. Gunther, early in the twentieth century.²

Another copper region that has been mined intermittently, at least since the second millenium B.C. to the present, is the Rio Tinto in southern Spain—first by the Phoenicians and later by the Romans, who were followed by the Moors, and today by the European company that bears its name, Rio Tinto-Patino. The Romans extracted millions of tons of ore from the Rio Tinto mines, which went to a depth of 1,000 feet. But while their smelting technique was sufficient for oxide ore, it was the Moors who developed the metallurgy for recovering pure copper from the more accessible copper sulfides.³ The Rio Tinto mines

¹ The David Livingston Museum in Livingston, Zambia has a remarkable collection of native copper instruments and utensils in use during the time of Livingston.

² In 1922 Cyprus Mines, Inc. began shipping copper from the Cyprus mines last worked by the Romans 1,600 years before. See Ira B. Joralemon, *Copper* (Berkeley, Howell-North Books, 1973) for a fascinating history of copper mining.

³ Joralemon, *Copper*, pp. 31–32.