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THE IMPACT OF POLICIES ON MINERALS PROCESSING IN LESS-DEVELOPED COUNTRIES

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Prepared for:

Office of External Research
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SRI International

EXECUTIVE SUMMARY

The Office of External Research, the U.S. Department of State, engaged SRI International to:

- Analyze factors affecting the location of processing facilities of selected minerals in the less-developed countries (LDCs).
- Forecast the levels of production by level of processing in the LDCs and developed countries (DCs) over the period 1980-1990.
- Evaluate the policies of LDCs and DCs that could affect the distribution of processing facilities.

Policy analysis of mineral processing cannot be performed effectively in the aggregate or by stage of processing. For both DCs and LDCs, commodity-by-commodity economic analysis by stage of processing and then country-by-country review of specific policies are required.

The minerals selected for specific analyses are bauxite, copper, and iron. Forecasts of consumption and production in major countries are based on existing plans and policies.

Policy analysis of LDCs focused on a review of major mineral producers including:

Major Producer	Mineral
Jamaica, Brazil, Surinam, Guyana, Guinea, Indonesia, Venezuela	Bauxite
Chile, Peru, Zambia, Zaire	Copper
Brazil, India, Liberia, Venezuela	Iron and steel

From the reviews of these countries, the following three were selected for more intensive policy analysis: Jamaica (bauxite), Zambia (copper), and Liberia (iron ore).

The analysis of policies of DCs affecting location of processing facilities centered on those of the United States. Included in the analysis were policies on tariffs, the generalized system of tariff preferences, guarantees of foreign private investment, quantitative restrictions on trade, and World Bank financing.

Research Approach

The methodology consisted of several detailed analyses and economic forecasts to determine the effects of policies on mineral processing in LDCs. First, a technoeconomic profile was compiled, and production, consumption, and trade by stage of processing were forecast for each mineral. Second, LDC and DC policies were examined in relation to their effects on production and trade.

Selected policies of each LDC were examined to determine their effect on private-sector decisions to invest in local processing facilities. Quantitative analysis was based on previously published data. The structure of the analysis is shown in Table S-1.

The analysis in each case began with the identification of the potential advantages and disadvantages for LDCs to process minerals within their countries. These possibilities were considered with regard to income, foreign exchange, employment, investment, production, and secondary linkages. The analysis then determined how selected LDC policies would influence private-sector attitudes and decisions if the processing provides a net advantage to the LDC. These attitudes and decisions are affected by policies on exchange rates, investment controls, labor market restrictions, taxes, and credit and ownership and by the political environment.

Economics of Minerals Processing

The economics of locating minerals processing facilities differ by mineral and by stage of processing. These differences are capsulized below.

Aluminum processing from alumina is dependent on low-cost energy (usually hydroelectric) and may be done away from the source of the alumina.* On the other hand, the substantial savings in transportation costs make it economical to process bauxite to alumina at or near the bauxite source.

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*The two stages of processing bauxite are alumina refining and aluminum smelting. The first stage, alumina refining, most commonly consists of the extraction of alumina from bauxite through the Bayer process. The second stage, aluminum smelting, is achieved through the use of the Hall-Heroult process.

Table S-1

POLICY ANALYSIS TYPOLOGY

Macropolicies	Mineral-Specific Aspects: Policy Instruments	Mineral-Specific Aspects: Constraints
Trade	Tariffs Quantitative restrictions, non-tariff barriers Export and import subsidies & taxes	Marketing agreements
Investment	Ownership Repatriation Concessions Income tax Royalties Depreciation	Investment climate Mining code/policies Foreign technology Resource base Energy Pollution Real costs Foreign exchange
Monetary	Exchange rates Capital markets Borrowing and credit	Savings Inflation Interest rates
Fiscal	Infrastructure Operating subsidies Income tax	Budget

Processing of ore into smelted and refined copper is now done economically at or near the location of the mine.* Copper processing is accomplished in two stages: smelting and refining. Refining normally is most economically done in the same facility as the smelting because the copper needs to be heated only once.

Iron ore and iron processing facilities generally are located near the markets for final products rather than the iron ore source.† The costs of transporting iron and steel are not significantly different enough from those for iron ore to warrant locating processing facilities near the mine site. For most types of pig iron and steel, large-scale production and dependable markets are important factors in determining cost advantages. The LDCs generally have small domestic markets for steel products and have difficulty selling their products in international markets.

Trends in Mineral Processing in Less-Developed Countries

Expansion of minerals processing in LDCs is forecast on the basis that substantial changes will not occur in current DC or LDC policies or the current general investment climate in the principal mineral-producing LDCs. Policy changes, for the most part, would not be expected to affect production before 1985. The historic and forecast share of LDC production by mineral and stage of processing is shown in Table S-2. The expected trends for the three minerals are summarized below:

- Copper--LDCs are expected to increase their share of world first-stage copper processing (smelting) from 35% in 1975 to 42% in 1985 and second-stage processing (refined copper) from 24% to 34% in the same period. Their share of copper ore production will rise more slowly, from 45% to 49% during this period.

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*The two stages of copper processing are smelting and refining. In the first stage, the dried copper concentrate is melted, at which point the reduced copper becomes about 94% pure and is separated from the iron slag. The second stage is the purification stage and includes electrolytic refining of the copper.

†Iron ore is processed first into pig iron and then into steel. The process is typically performed in an integrated steel mill at one location.

Table S-2

LESS-DEVELOPED COUNTRIES' SHARE OF WORLD MINERALS PRODUCTION
BY STAGE OF PROCESSING AND WORLD CONSUMPTION
1955-1990
(In Percent)

	Mine Production			Stage I Processing			Stage II Processing			Consumption		
	Bauxite	Copper	Iron	Alumina	Smelter Copper	Pig or Sponge Iron	Aluminum	Refined Copper	Steel	Aluminum	Copper	Steel
1955	--	14	13	--	37	5	--	17	3	--	4	7.8
1960	58.5	46	27	--	39	15	1.0	19	9	2.7	6	12.2
1965	56.6	43	29	15.6	37	10	2.1	20	7	4.0	7	10.5
1970	54.4	41	30	20.1	34	9	3.7	21	8	5.4	7	11.9
1975	47.8	45	34	18.6	35	11	7.4	24	10	7.3	12	13.4
1980	*	45	34	19.2	38	11	8.5	29	12	6.9	12	17.3
1985	*	49	36	22.1	42	15	16.2	34	16	7.4	15	19.6
1990	*	51	39	--	44	19	--	37	21	--	18	22.3

*Slight decline.

Source: SRI International

- Bauxite--Modest growth from 19% in 1975, is expected in the LDC share of alumina production but the share of aluminum production is expected to increase from 7% to 16% by 1985. The share of LDC bauxite production is expected to fall slightly in this 10-year period.
- Iron--LDC's share of both first-stage (pig) and second-stage (steel) iron ore processing is expected to grow from 10%-11% in 1975 to 15%-16% by 1985. Most of the growth in iron processing will be in the larger LDCs to serve their domestic markets. LDC share of iron ore production will grow more slowly from 34% to 36% in this time frame.

Public Benefits Versus Private Returns

The employment, balance-of-payments, and value-added benefits from mineral processing in LDCs appear to be relatively small in the cases examined in this study. Processing of minerals is capital-intensive, requires substantial imported machinery and equipment, and adds far less domestic value than does mining itself. Government policies designed to effectively influence decisions in favor of locating processing facilities within the countries do not appear to have substantial social benefits to outweigh the costs to be incurred.

Tax revenues to the ore-producing country are based principally on the "economic rent" provided by the mineral resource itself rather than from the processing facility. Thus the existence of a local processing facility would not substantially increase tax revenues relative to taxes earned on the production and sale of ore.

Description of Policies in Less-Developed Countries

Four basic types of policies are identified that affect the location of forward processing of minerals. These policies are listed in order of importance in Table S-3.

- Monetary and capital policies cover exchange rates, borrowing, and credit. The ability of private operators to finance construction and operations of forward processing facilities and the price (in host country currency) of the processed minerals influences profitability and return on investment.
- Fiscal policies deal with providing needed infrastructure, subsidizing government--or even privately owned companies, and taxing income earned by companies and individuals.
- Labor policies that affect forward processing cover training programs, wage laws, and requirements to train and/or use local workers.
- Trade and investment policies include restrictions on imports or exports, ownership rights, and control of plant operations.

Table S-3

TYPES OF POLICIES THAT AFFECT MINERALS PROCESSING IN LESS-DEVELOPED COUNTRIES

Policies	Examples of Macroapplication	Examples of Mineral-Specific Application
Monetary and capital		
Exchange rate	How should the exchange rate be set?	Should the exchange rate discriminate against or in favor of mineral industries?
Borrowing and credit	Is the supply of funds available for credit sufficient?	Should the government reduce the cost of credit by giving loan guarantees to the mineral sector?
Fiscal		
Infrastructure	How should the government spend its funds to build infrastructure?	Through what channels can the government best provide infrastructure particularly suited to further mineral processing?
Subsidies	Should any portion of the economy be subsidized?	Should the minerals industry in particular be subsidized?
Income tax	At what rate should an income tax be applied?	Should minerals companies be taxed at a rate different from other companies?
Labor		
Training	How should the government help schools and universities to adjust their programming to meet the needs of their economy?	Under what circumstances should the government specifically encourage increased capacity for the training of minerals processing managers or laborers?
Wages	Should minimum wages be established?	Should a different minimum wage be set for minerals company employees?
Trade and investment		
Quantitative restrictions and nontariff barriers	What types of restrictions should be placed on importing and exporting goods and services?	When should restrictions and barriers be different for the minerals industry than for other sectors?
Ownership	How should a distinction be made between when private ownership is or is not appropriate?	Should minerals activities be treated differently from other activities in the economy?

Impacts of Policies of Less-Developed Countries

Monetary, capital, fiscal, labor, investment, and trade policies in LDCs have widely varying effects on the minerals sectors in each country. The extent of a country's economy-wide or mineral-specific policies on processing may be determined only by examining the individual country. However, some generalizations can be made with respect to impacts expected by stage of processing, as shown in Table S-4 and discussed below.

- LDC policies can influence but, within reasonable policy limits, cannot determine where minerals processing facilities should be located. The underlying economic characteristics of specific mineral technologies, costs, and markets provide the key determinants for this decision.
- LDC policies can influence the level of investment in local mineral extraction; in some cases, this also influences the level of investment in local processing facilities.
- LDC policies primarily influence mining and processing investment at the initial stages of investment deliberations.
- Government policies have their strongest effects on first-stage bauxite and copper processing. In second-stage alumina processing or first-stage iron ore processing, the economic disadvantage of locating facilities near the prior stage of production cannot be overcome without substantial government subsidies.
- Policy stability rather than the specific characteristics of any single policy or policy change probably is more important because it affects long-run investment decisions. Further, the combination of policies directly or indirectly affecting mineral and processing investments in most cases is far more important than any single specifically mineral-related policy.
- The LDC macropolicies are ranked as monetary, exchange, and tax policies being most important; labor and employment policies are important; and trade and investment policies appear least important. Expropriation is considered separately.
- Less overvalued exchange rates, increased availability of credit, and reduced levels of taxation all increase profitability. However, they are most effective on first- and second-stage copper processing and first-stage bauxite processing.
- Provision of adequate infrastructure, increased training of nationals, and attractive wages for minerals processing personnel serve predominately to increase profitability in the long term.
- The increased profitability from policies specified would in turn increase the quantity of processing in the LDCs. The DCs would also be affected through heightened international competitiveness caused by higher returns in the DCs. Depending on relative cost structure, DCs may be forced to operate more efficiently (at lower cost) or to increase their levels of protection from imports.

Table S-4

POLICIES IN LESS-DEVELOPED COUNTRIES THAT AFFECT MINERALS PROCESSING BY STAGE OF PROCESSING

	Copper		Bauxite		Iron Ore	
	Stage I	Stage II	Stage I	Stage II	Stage I	Stage II
Monetary and capital						
Exchange rate	X	X	X			
Credit	X	X	X			
Fiscal						
Infrastructure	X	X	X	X		
Subsidies	X	X	X		X	X
Tariffs and taxes	X	X	X		X	X
Labor						
Training	X	X				
Wages	X	X				
Trade and investment						
Tariffs, Quantitative Restrictions, Nontariff Barrier	X	X	X		X	X
Ownership	X	X	X		X	X
Other						
Bauxite levy			X	X		
Expropriation	X	X	X	X	X	X

- Several policies reduce profitability and production of minerals processing in LDCs. At a minimum, the economic efficiency of such operations will deteriorate and possibly require subsidization. DC processing operations would appear more attractive and may thus be increased. The return-reducing policies are:
  - More overvalued exchange rates
  - Reduced availability of credit
  - Increased levels of taxation
  - Inadequate provision of infrastructure
  - Reduction in training of nationals
  - Inadequate wages for minerals processing personnel.
- The bauxite levy specifically acts to reduce the returns from bauxite mining and perhaps alumina and aluminum production. All other things being equal, imposing this levy will in the long run shift such production away from the LDCs that impose it. Bauxite producing DCs should benefit.
- Expropriation inhibits further private investment; because large capital resources are required for mineral investment, such actions may also deter financing of substitute investment by the public sector.
- The effects of expropriation policies of LDCs vary, but would be expected to shift production away from the developing to the developed countries. Processing in LDCs would be decreased, and proportionately increased in DCs.
- Trade and investment policies of LDCs have less noticeable impacts on both the LDCs and the DCs. Import restrictions and protective tariffs are effective in securing the domestic market for domestic production. However, such policies lead to high-cost goods and are effective only in large countries.
- Private foreign participation in minerals extraction and processing in most LDCs is often at least a preliminary prerequisite to the development of the minerals sector. The sums of money required for projects of this type are normally so large that public funds, even those available in relatively large amounts (such as those of the International Bank for Reconstruction and Development), are inadequate. If an LDC wants to forward process its minerals either in the present or in the near future, it is often to the country's advantage to have amiable relations with private corporations. The LDC can do this in part through a set of policies that are attractive (or at least not unattractive) to private interests.

Description of Policies in Developed Countries

The key policies of DCs determined to significantly impact minerals processing in LDCs were identified and are shown in Table S-5. They include trade, investment, and tax policies. Trade policies were found to be most important in inhibiting the flow of processed minerals into major markets of the DCs.

Tariffs are the most common form of trade policies. Because they either add to the price of the product paid by the consumer, reduce the price received by the producer, or some combination of the two, they reduce the competitive position of minerals processed in LDCs or other exporting nations.

The general structure of tariffs also influences the structure of trade and international distribution of investment. Tariffs are usually low or nonexistent for raw materials and tend to increase with the degree of processing. This structure keeps prices low for raw materials paid by mineral processors in DCs, but it permits increases in prices they can charge for processed minerals. Thus, their profit margins on processing and the rate of return on investment are expanded.

Most DCs have instituted a general system of preferences (GSP) to help LDCs develop their manufacturing and industrial base. GSP reduces tariffs on many products manufactured in LDCs. The GSP helps counteract the impediments to trade arising from tariffs, but the actual extent of its coverage of minerals products is rather narrowed by a variety of limitations.

Nontariff barriers also inhibit LDC exports to DCs. Examples are the current reference or minimum pricing on steel products imported into the United States and a potential restriction on imports of copper shapes into the United States.

The Overseas Private Investment Corporation (OPIC) has been established in the United States to provide insurance and guarantees against noncommercial losses, including foreign exchange convertibility, war, and expropriation, sustained by private companies investing in LDCs. Similar programs have been initiated in other DCs, and this type of action helps to offset risks inherent in overseas investments and to encourage more private investment in LDCs.

Tax policies of DCs affect the rate of return on investment received by multinational companies investing in LDCs. The savings from reduced taxes on income earned in LDCs could be used to encourage direct investment in forward processing.

Table S-5

TYPES OF DEVELOPED COUNTRY POLICIES THAT AFFECT MINERALS PROCESSING

Policies	General Applications	Specific Examples
Trade		
Nominal tariffs	Tariffs set to inhibit imports of products into DCs	Tariffs of about 7% charged on steel product imports
Effective protection	No or very low tariff for raw materials; higher tariffs for processed materials	No tariffs on bauxite or alumina imports; tariffs of 6% on wrought alumina imports
The generalized system of preferences	Elimination or reduction of tariffs or products produced in LDCs	20% of LDC exports of copper products to United States enter duty-free
Nontariff barriers	Inhibit imports of products into DCs	Reference or minimum pricing for iron and steel imports
Investment		
Investment guarantees and insurance	Risk insurance for companies and banks investing in LDCs	Insurance covering $1.3 million in U.S. company aluminum ingot manufacturing plant in Brazil
Tax		
Income tax	U.S. tax policy changes rate of return on investment for U.S. companies' investments in LDCs	Because of 1976 Tax Reform Act, reduced tax rate for U.S. corporations operating in Latin America will be eliminated.

Impacts of Developed Country Policies

Most of the findings on policies of DCs are mineral-specific. Generalizations are difficult to make. However, it was found that:

- Policies of DCs tend slightly to be discouraging forward processing in LDCs.
- Trade barriers of DCs restrict the entrance of processed minerals into major markets.
- Policies of DCs are not significant in expanding direct investment in minerals processing in LDCs.
- Loans, investment, and policy guidance offered by international financial institutions can be significant for LDC investment in minerals and mineral processing.
- OPIC policies to provide more attractive insurance and guarantee terms and to expand financing for mineral investment may stimulate additional processing of bauxite and alumina in several LDCs, but it is not clear that they will. Restrictions on OPIC services for copper investment effectively preclude their help in the area most logical to attract investment.
- The increased U.S. personal income tax burden on persons working abroad will serve to increase the cost and reduce the supply of U.S. nationals available to work in LDC mineral industries.

Findings concerning policies of DCs affecting processing of specific minerals in LDCs are as follows:

- Reductions in U.S. tariffs on copper products would provide general support for additional processing and/or revenue in LDCs, possibly Chile, Zaire, and Peru. However, the problem of financing probably is a more significant deterrent to expanding facilities in LDCs than the current tariffs.
- Reductions in U.S. tariffs on aluminum products would provide general support for additional processing in LDCs, possibly Brazil and Indonesia.
- Reductions in U.S. tariffs on steel would not provide substantial support for steel production in LDCs because most LDCs do not enjoy internationally competitive cost or quality advantages.
- Exclusion from GSP for 90% of U.S. copper imports from LDCs effectively reduces the value of GSP for almost all copper product exporting LDCs. In view of other actions under consideration to limit imports, there is little likelihood that the competitive need criteria will be relaxed for copper.
- GSP provides some incentive for LDC aluminum exports to enter the U.S. market.

- GSP probably does not stimulate processing of iron ore in ore-producing LDCs. Rather, it provides an advantage for Taiwan and South Korea, which process imported ore.
- Reference pricing on steel imports to trigger anti-dumping tariffs will restrict U.S. entry of low-cost foreign steel. At this time, it is not clear that this does provide disincentives to LDCs processing for export because of their relatively noncompetitive position.
- U.S. quotas on specialty steel imports do restrict the market for selected LDCs--Brazil, Argentina, and Korea; however, they account for a small share of U.S. imports.
- Any further restriction on U.S. copper imports through higher tariffs or quotas would be a disincentive to investment in processing in LDCs.
- U.S. export restrictions on scrap steel, effective in 1973-74, provided a disincentive for steel manufacturers in LDCs to build low-cost facilities dependent on imported scrap to meet domestic or foreign demand. A statement by the United States to avoid future export restrictions could tend to remove this disincentive.

Summary

It does not appear to be in the interest of the LDCs, DCs, or the United States to take a position in favor of the adoption of special policies of developed or developing nations directed toward the promotion of minerals processing in LDCs. Each country, each mineral, and each stage of processing need to be examined separately to determine the costs and benefits of specific policies in each case.

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PREFACE

Research for this report was carried out by SRI International under contract with the Office of External Research, U.S. Department of State. Mr. Warren Reynolds served as contract technical representative. The project was initiated in June 1977.

Research for the project was conducted under the direction of Donald S. Green, Associate Executive Director, Management and Economics Division and Mark Earle, Director of the Center for Economic Policy. Dr. Frank Jones served as project leader during Phases I and II and was responsible for project working papers. Data and analysis of minerals economics were provided by Leons Kovissars (copper), John Moberly (aluminum), and William Morris (iron and steel). The policy analyses, evaluation, and report drafting in Phase III were directed by Donald Green and were prepared by Dale Benveniste (less-developed countries) and Claire Starry (developed countries). Dr. Scott Pearson and Dr. John Page of the Food Research Institute served as consultants for the policy analysis.

SRI International acknowledges with thanks the support and advice provided by the Department of State and by the members of the interagency review committee. In addition, we wish to acknowledge the cooperation provided by the Office of the Special Trade Representative, the Overseas Private Investment Corporation, and the International Bank for Reconstruction and Development.

I INTRODUCTION

Purpose

The purpose of this project as stated initially by the Department of State was to:

- Study the forces that encourage, limit, or inhibit the processing of raw materials within the less-developed countries (LDCs).
- Identify opportunities over the next decade for expanding such processing.
- Analyze the impacts of such processing on the world economic system, particularly in the United States.

The study focuses on the iron, steel, aluminum, and copper industries, but examines the lessons learned for possible applicability to other areas.

At the first meeting of the interagency review group, the following more specific objectives were agreed upon:

- Examine the following factors that affect the distribution of investment and production by level of processing in selected LDCs and developed countries (DCs):
  - Basic economic factors
  - Economic and political policies of LDCs
  - Economic and political policies of DCs.
- Develop a baseline 15-year forecast of the distribution of investment and production by level of processing in selected developing and developed countries on the basis of current and expected policies.
- Identify the policy changes that could affect this pattern of distribution and evaluate the likely effects of these policy changes.

During the second in-process review of working papers held on March 1, 1978, additional emphasis was placed on identifying policies of DCs and LDCs and on examining the impacts of such policies on both. Following the March meeting, agreement was reached to concentrate the report on policy assessments, treating the descriptive material developed on the technology, and markets and costs as background working papers. This report is designed to serve the needs of the policy-oriented audience.

Scope

The study was limited to an analysis of aluminum, copper, and iron, with implications to be drawn for the general field of minerals processing, if possible. The time period examined included 1960 to 1977 with forecasts through 1990.

Case studies of specific countries were used as appropriate to identify policies and economics necessary to form the basis for analysis. Countries examined included:

Aluminum:	Jamaica, Brazil, Surinam, Guyana, Guinea, Indonesia, Venezuela
Copper:	Chile, Peru, Zambia, Zaire
Iron:	Brazil, India, Liberia, South Korea, Taiwan, Venezuela.

Detailed analysis of three LDCs was conducted. The decision as to which countries to examine in detail was based predominantly on the relative magnitude of production and the availability of information regarding the mineral sectors of the respective economies. Country selection also considered variety in the form of ownership of the mineral companies such that each case study reflected different patterns of control and ownership. Detailed policy studies were made of Jamaica (aluminum), Zambia (copper), and Liberia (iron). Analysis of policies of DCs was limited principally to the United States, and to tariffs, quantitative restrictions, and foreign investment incentives.

Methodology

The research was conducted in several tasks. Industrial profiles were developed for each mineral, including technology, costs, markets, and financing. Existing policies of DCs and LDCs affecting minerals processing were described. Forecasts were made of consumption and production by stage of processing for principal DCs and LDCs.

The analysis and evaluation of policies affecting minerals processing were divided into DC and LDC policies. For DC policies, attention was focused on U.S. tariffs, the generalized system of tariff preferences, U.S. quantitative restrictions (where appropriate), U.S. foreign investment insurance and guarantee program, and financing by the World Bank.

The conceptual framework used for LDC policy analysis and evaluation was to determine factors affecting private profits under specified sets of policies and then to evaluate the factor and product market distortions introduced by specific policies in terms of the likely effect on processing investment decisions.* Quantitative analysis was based on information from previously published material. A typology of policies and policy constraints was used, as shown in Table 1, to structure the analysis.

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*See Scott R. Pearson and John Cownie, Commodity Exports and African Economic Development (D.C. Health and Company, 1974).

Table 1

POLICY ANALYSIS TYPOLOGY

Macropolicies	Mineral-Specific Aspects: Policy Instruments	Mineral-Specific Aspects: Constraints
Trade	Tariffs Quantitative restrictions, non-tariff barriers Export and import subsidies & taxes	Marketing agreements
Investment	Ownership Repatriation Concessions Income tax Royalties Depreciation	Investment climate Mining code/policies Foreign technology Resource base Energy Pollution Real costs Foreign exchange
Monetary	Exchange rates Capital markets Borrowing and credit	Savings Inflation Interest rates
Fiscal	Infrastructure Operating subsidies Income tax	Budget

The policy evaluation methodology is designed to assist in answering a set of questions. First, what are the advantages and disadvantages for LDCs of processing minerals in LDCs? These include income, foreign exchange, employment, investment, production, and secondary linkages. It is noted that once the economic rent is collected from natural resource extraction, it cannot be taken in multiples on each stage of processing.

Second, if the LDC gets a net advantage from processing, how do selected LDC policies influence private sector attitudes and decisions? These are affected by exchange rate policies, investment controls, labor market restrictions, tax, credit and ownership policies, and the political environment.

These questions were addressed in the policy analysis. For each mineral and each country examined, the basic economic structure of the industry was described and analyzed. Then, the existing sets of policies affecting investment, production, and trade were specified and analyzed in terms of their impact on the level of processing.

II MINERALS PROCESSING: ECONOMICS AND OUTLOOK

This chapter presents both background on the importance of the LDCs in providing and processing aluminum, copper, and iron and steel, and historical and forecast data on the degree of the processing of these minerals in the LDCs. It also provides an overview of the factors that affect the degree of processing in the LDCs, including technology, costs, markets, and government policies. These discussions are based primarily on the technoeconomic factors for each of the three minerals presented in the three working papers on the minerals and the descriptions of policies of individual countries presented in the policy working paper annex.

Trends in Mining and Processing in Less-Developed Countries and Assumptions Used

Table 2 summarizes the principal historical data and SRI forecasts for aluminum, copper, and iron and steel, presented in terms of the LDC share (percent) of worldwide mining and Stage I and Stage II processing. Historical data presented are taken from numerous issues of Metallgesellschaft and World Metal Statistics. Forecasts (for 1980 and beyond) have been projected by SRI. The forecasts are based both on specific plants and plant expansions of which SRI is presently aware and on the past experience of SRI's minerals staff derived from conducting many projects about these minerals. Further, SRI based its forecasts for alumina and aluminum production on the assumption that non-bauxitic reserves will not be an important source of aluminum production through 1990.

As Table 2 indicates, the LDCs have been accounting for a declining share of world bauxite production, an increasing share of iron ore, and since 1970 an increasing share of copper ore production. These trends are expected to continue.

For first-stage processing of alumina, copper smelter, and pig or sponge iron, LDCs are expected to continue increasing their share, begun in 1970. For second-stage processing in all three minerals, the LDCs are expected to continue their long-standing increase in share. By 1990, the LDCs will have increased their share of world copper smelting by 30% and refining by 50% from 1975; for processed iron and steel, the share will increase by 73% and 100%; for alumina, the share will rise slightly, but for aluminum, the share will more than double.

Thus the outlook for more processing of minerals in the LDCs is very positive, i.e., it is growing in absolute and relative terms. These forecasts are based largely on known plans for specific investments country by country.

Table 2

LESS-DEVELOPED COUNTRIES' SHARE OF WORLD PRODUCTION
BY STAGE OF PROCESSING AND WORLD CONSUMPTION
1955-1990
(In Percent)

	Mine Production			Stage I Processing			Stage II Processing			Consumption		
	Bauxite	Copper	Iron	Alumina	Smelter Copper	Pig or Sponge Iron	Aluminum	Refined Copper	Steel	Aluminum	Copper	Steel
1955	--	41	13	--	37	5	--	17	3	--	4	7.8
1960	58.5	46	27	--	39	15	1.0	19	9	2.7	6	12.2
1965	57.6	43	29	15.6	37	10	2.1	20	7	4.0	7	10.5
1970	54.4	41	30	20.1	34	9	3.7	21	8	5.4	7	11.9
1975	47.8	45	34	18.6	35	11	7.4	24	10	7.3	12	13.4
1980	↓	45	34	19.2	38	11	8.5	29	12	6.9	12	17.3
1985		49	36	22.1	42	15	16.2	34	16	7.4	15	19.6
1990	Slight Decline	51	39	--	44	19	--	37	21	--	18	22.3

Source: SRI, with information from Metallgesellschaft and World Metal Statistics (numerous issues)

In the aggregate, the LDC share of world production of aluminum, copper, and steel is forecast to rise substantially faster than the LDC share of world consumption. Thus developed countries will be importing relatively more processed minerals from the LDCs than from DCs.

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Economics of Processing Bauxite and Alumina

It is usually more economically efficient to process bauxite into alumina at the mine site than at any other location because bauxite transport costs are high and it can be economical to use imported energy. As shown in Figure 1, it takes from 4 to 7 tons of bauxite to make 2 tons of alumina. Shipping bauxite to alumina production facilities can increase the cost of delivered bauxite by up to 50%. Although alumina production facilities are energy-intensive, they are not extremely energy-intensive (as are aluminum facilities); and they usually run on thermal energy. At current prices, these factors allow for relatively cost-effective alumina production using imported energy supplies.

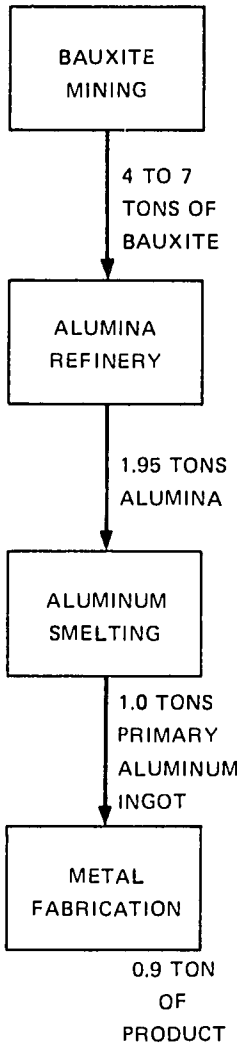
In light of the above, alumina production has increasingly been taking place in principal LDC bauxite mining areas. In 1966, Canada, West Germany, France, Japan, and the United States together produced 56% of the world's alumina from imported bauxite. Table 3 shows that Jamaica and Surinam almost tripled their alumina production levels in the period 1965 to 1975. By 1975, production from the five developed countries had decreased to only 37% of the total. Through 1985, Jamaica and Surinam as well as Guinea, Guyana, and Brazil are all expected to increase the amount of alumina they will be producing, with the largest relative increase coming from Brazil.

Even though alumina production is increasing in the LDCs, it has changed little in relative terms. The LDC share of alumina production as a total of all alumina production is as follows:*

Year	Percent
1965	15.6
1970	20.1
1975	18.6
1980	17.1
1985	20.2

The reason for the decrease between 1970 and 1980 is the rapid expansion of alumina production in Australia and Japan, the former a bauxite mining country and the latter an importer of bauxite. By 1980, Japan's expansion of alumina production will end, but Australia's will continue through 1985.

Sources: Metallgesellschaft, SRI International



	ELECTRIC POWER (kilowatt hours)	THERMAL ENERGY (million Btus)
ALUMINA REFINERY	500	30
ALUMINUM SMELTING	17,500	6

*Btu = British Thermal Unit.

SOURCE: SRI International

FIGURE 1 SIMPLIFIED ALUMINUM PRODUCTION CYCLE

Table 3

PRODUCTION OF BAUXITE, ALUMINA, AND ALUMINUM BY COUNTRY
1965-1975 AND OUTLOOK
(Millions of Metric Tons)

Production	1960	1965	1970	1975	Ten-Year Outlook
Jamaica					
Bauxite	5.8	8.7	12.0	11.6	No significant growth
Alumina	--	0.8	1.8	2.2	2.9 by 1985
Aluminum	None	None	None	None	None
Surinam					
Bauxite	3.5	4.4	6.0	4.8	Slight growth
Alumina	--	0.4	1.0	1.1	1.4 by 1985
Aluminum	--	0.03	0.05	0.04	
Guinea					
Bauxite	1.4	1.6	2.5	10.6	Strong growth
Alumina	--	0.5	0.6	0.6	1.2 by 1985
Aluminum	None	None	None	None	None
Guyana					
Bauxite	2.5	2.9	4.4	3.8	Slight growth
Alumina	--	0.3	0.3	0.3	0.5 by 1985
Aluminum	None	None	None	None	None
Brazil					
Bauxite	0.1	0.2	0.5	1.3	Strong growth
Alumina	--	0.1	0.1	0.2	1.2 by 1985
Aluminum	0.02	0.03	0.06	0.12	0.7 by 1985

Sources: Metallgesellschaft for actual figures;
SRI International for 10-year outlook

Currently, Australia, the United States, Yugoslavia, Greece, France, the USSR, Romania, Hungary, and China all mine bauxite (see Table 4). As a group, the DCs mined more bauxite than the LDCs in 1975; DCs produce 42 million metric tons of bauxite compared with 38 million metric tons produced in LDCs. Shifting alumina production to bauxite-mining countries could conveivably leave shares between developed countries and developing countries unchanged.

The economics of aluminum production are quite different from those of alumina production. Aluminum smelters are extremely energy-intensive and use mainly hydroelectric (rather than thermal) energy. The availability of low-cost power has been the major determining factor in smelter site location. Developing countries have about 65% of potential hydroelectric resources, but account for only 20% of the world's hydroelectric energy output. As a result, aluminum production has remained mainly in the developed countries. LDCs account for approximately 7.5% of current aluminum production. This is an increase from the 1965 level of less than 1%, but is still quite small.

Those LDCs that produce aluminum are not necessarily those that produce bauxite. Only Brazil and India, two relatively minor producers of bauxite, produce aluminum. The major developing country bauxite producers, Jamaica and Guinea, do not have aluminum smelters. Further, several developing countries process alumina from other countries (see Tables 5 and 6). The countries engaged in processing imported alumina are Venezuela (refining alumina imported from Jamaica), Mexico, Ghana, Argentina, and Indonesia (using alumina imported from Australia).

There are greater economics of scale in alumina production than in aluminum production. Aluminum plants consist of groups of potlines, the average capacity increment being 80,000 metric tons per year. There are recommended minimum and maximum sizes for aluminum plants,* but these do not usually interfere with the development of aluminum smelters where other conditions (i.e., inexpensive energy) are appropriate.

Alumina plants are usually built on a larger scale,† and often capital costs per unit of output are reduced when larger plants are built. The minimum sizes, however, are of a magnitude which do not turn out to be restrictive to most potential alumina producers.

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*For an aluminum plant, minimum plant size is 60,000 to 80,000 metric tons per year; maximum size is 320,000 metric tons per year.

†For an alumina plant, minimum plant size is 400,000 metric tons per year, maximum size is 2,000,000 metric tons per year.

Table 4

PRODUCTION OF BAUXITE
(Thousands of Metric Tons)

	1960	1965	1970	1975	Ten-Year Outlook
Developed countries					
Oceania					
Australia	70	1,186	9,256	21,003	Continued strong growth
North America					
United States	2,030	1,680	2,115	1,831	No significant growth
Western Europe					
France	2,067	2,664	3,051	2,563	Slight decline
Greece	884	1,274	2,292	3,244	Strong growth
Yugoslavia	1,025	1,574	2,099	2,306	Strong growth
Subtotal	3,976	6,512	7,442	8,113	
Eastern Europe					
USSR	3,500	4,700	5,400	6,000	No significant growth
Romania	88	108	776	779	No significant growth
Hungary	1,190	1,478	2,022	2,889	Slight growth
Subtotal	4,778	6,286	8,198	9,668	
Total--DCs	10,854	15,664	27,011	40,615	
Developing countries					
Latin America					
Brazil*	121	188	510	1,277	Strong growth
Dominican Republic	689	942	1,086	785	No significant growth
Guyana	2,511	2,919	4,417	3,829	Slight growth
Haiti	347	383	657	522	No significant growth
Jamaica	5,837	8,651	12,010	11,571	No significant growth
Surinam	3,455	4,360	6,022	4,750	Slight growth
Venezuela	--	--	--	--	Possible growth
Subtotal	12,960	17,443	24,702	22,734	
Africa					
Guinea	1,378	1,600	2,490	10,641	Strong growth
Ghana	194	319	337	353	No significant growth
Sierra Leone	--	207	449	716	Slight growth
Subtotal	1,572	2,126	3,276	11,710	
Asia					
China	350	400	500	800	No significant growth
India	387	707	1,374	1,268	Slight growth
Indonesia	396	688	1,229	992	No significant growth
Malaysia	459	857	1,139	703	No significant growth
Turkey	--	10	52	570	No significant growth
Subtotal	1,242	2,262	4,794	3,533	
Total--LDCs	16,124	22,231	33,272	38,777	

*Major new bauxite sources are being developed in the remote Amazon region.

Sources: Metallgesellschaft and World Metal Statistics for actual figures; SRI International for 10-year outlook

Table 5

PRODUCTION OF ALUMINA
(Thousands of Metric Tons)

	Actual			Projected	
	1966	1970	1975	1980	1985
Developed countries					
Oceania					
Australia	307	2,152	5,127	7,000	10,200
North America					
Canada	900	1,105	1,134	1,250	1,250
United States	5,310	6,050	4,738	7,200	8,300
Subtotal	6,210	7,155	5,872	8,450	9,550
Western Europe					
France	845	1,004	1,089	1,300	1,300
Germany, F.R.	603	757	1,246	1,750	2,100
Greece	73	312	475	600	1,200
Italy	270	313	697	950	1,150
Spain	--	--	--	400	800
Turkey	--	--	46	200	200
Yugoslavia	95	125	297	1,500	1,500
Ireland	--	--	--	--	800
Subtotal	1,886	2,511	3,850	6,200	9,050
Eastern Europe					
USSR	2,600	2,600	3,400	3,800	4,500
Romania	95	200	400	500	500
Hungary	288	441	775	800	1,200
Czechoslovakia, E. Germany	--	--	--	150	150
Subtotal	2,983	3,241	4,575	5,250	6,350
Asia					
Japan	662	1,285	1,565	2,750	2,750
Other developed countries	245	232	230	300	1,100
Total	12,293	16,576	21,309	30,450	39,300
Developing countries					
Latin America					
Brazil	68	119	241	400	1,200
Guyana	302	317	303	300	400
Jamaica	804	1,797	2,242	2,850	2,850
Surinam	407	1,036	1,148	1,400	1,400
Venezuela	--	--	--	--	1,000
Subtotal	1,581	3,269	3,934	4,950	6,850
Asia					
India	170	327	337	750	1,250
Indonesia	--	--	--	--	400
China	180	270	350	600	600
Taiwan	--	--	--	160	160
Subtotal	350	597	687	1,510	2,410
Africa					
Guinea	525	610	639	700	1,200
Sierra Leone	--	--	--	--	500
Subtotal	525	610	639	700	1,700
Other developing countries	35	42	46	100	200
Total	2,491	4,518	5,306	7,260	11,060

Sources: Metallgesellschaft for actual figures; SRI International for projected figures

Table 6

PRIMARY ALUMINUM PRODUCTION
(Thousands of Metric Tons)

	Actual				Projected	
	1960	1965	1970	1975	1980	1985
Developed countries						
Oceania	12	88	206	323	400	550
North America						
Canada	691	753	962	880	1,050	1,400
United States	1,827	2,499	3,607	3,519	5,200	5,800
Subtotal	2,518	3,252	4,569	4,399	6,250	7,200
Western Europe						
France	235	340	381	386	450	500
Germany, F.R.	169	234	310	678	800	900
Italy	84	124	147	190	300	600
Netherlands	--	--	75	258	300	350
Norway	171	276	522	595	750	950
Spain	29	53	120	210	300	400
United Kingdom	29	36	40	308	350	450
Other Western Europe*	148	215	422	627	750	1,100
Subtotal	865	1,278	2,017	3,252	4,000	5,250
Eastern Europe						
USSR	700	1,200	1,700	2,150	2,500	2,500
Other Eastern Europe	155	238	366	480	600	900
Subtotal	855	1,438	2,066	2,630	3,100	3,400
Asia						
Japan	133	294	728	1,013	1,500	1,600
Africa	--	--	--	76	100	150
Total	4,383	6,359	9,586	11,693	15,350	18,150
Developing countries						
Latin America						
Brazil	18	30	56	121	225	650
Venezuela	--	--	22	52	350	350
Other Latin America	--	23	89	97	150	500
Subtotal	18	53	167	270	725	1,500
Asia						
India	18	64	161	167	300	400
Indonesia	--	--	--	--	--	250
Other Asia	8	19	44	225	300	700
Subtotal	26	83	205	392	600	1,350
Africa	--	--	--	273	400	650
Total	44	136	372	935	1,725	3,500

*Includes Yugoslavia and Turkey.

Sources: Metallgesellschaft for actual figures; SRI International for projected figures

Demand

Aluminum demand has increased over the last two decades. Table 7 summarizes past world primary metal consumption and gives SRI's future projections. Future growth rates are down significantly from growth rates in 1960-1974. However, despite these lower growth rates and because the level of aluminum consumption will be greater in the future, the absolute level of annual tonnage increases will be greater than in the past (see Table 8).

Table 7

PAST AND FUTURE GROWTH OF PRIMARY ALUMINUM CONSUMPTION

Year	Annual Growth Rate (percent)	Total Tonnage Growth (millions of metric tons)	Per Year Growth (millions of metric tons per year)
1960-1974	8.9	9.64	0.69
1976-1980	5.5	3.36	0.84
1981-1990	4.5	9.54	0.95

The major concern for the aluminum industry in view of projected consumption increases is its ability to expand production fast enough to meet estimated demand. Year-end 1976 aluminum smelting capacity was 15.7 million metric tons, about 1.5 million metric tons less than the projected 1980 demand.

For both alumina and aluminum production, the forecasts for 1980 are based on specific new plants and plant expansions of which SRI is aware. The 1985 and 1990 forecasts reflect SRI forecasts of world demand allocated among supplying countries based on technoeconomic considerations and SRI judgment of the likely evolution of political trends affecting investment country by country.

Industry Structure

The dominant characteristic of the international aluminum industry is the concentration of production of bauxite, alumina, and aluminum in a few major multinational companies. The six large integrated companies own over 50% of the world's bauxite production, about 60% of the alumina production, and nearly 50% of the aluminum production capacity. The great majority of trade in bauxite and alumina, and to a smaller extent aluminum, is accounted for either by ownership ties of the integrated multinational aluminum companies or by long-term contracts.

Table 8

ANNUAL WORLD PRIMARY ALUMINUM DEMAND
(Millions of Metric Tons)

	Actual						Projected*		
	1960	1965	1970	1974	1975	1976	1980	1985	1990
Western Europe	1.28	1.57	2.60	3.43	2.88	3.51	4.09	5.18	6.31
North America	1.64	3.02	3.70	5.47	3.80	4.77	6.16	7.46	8.71
Latin America and Africa	0.08	0.16	0.30	0.55	0.56	0.53	0.76	1.09	1.58
Asia	0.23	0.48	1.29	1.80	1.68	2.27	2.90	3.80	4.82
Total Western World	3.23	5.23	7.89	11.25	8.92	11.08	13.91	17.53	21.42
Total World	4.18	6.64	9.93	13.82	11.60	13.96	17.32	21.89	26.86

*Projected aluminum demand is determined on a country-by-country basis, for 30 countries (or regions). The methodology relates historical aluminum consumption with GNP and population. The past consumption pattern is then used, along with future GNP and population estimates to calculate future metal demand.

Sources: Metallgesellschaft and World Metal Statistics for actual figures; SRI International for projections

In 1974, seven bauxite-producing countries--Australia, Guinea, Guyana, Jamaica, Sierra Leone, Surinam, and Yugoslavia--established the International Bauxite Association (IBA). This group was expanded to 11 by 1975, with the addition of Haiti, the Dominican Republic, Ghana, and Indonesia; India is considering joining the group. The IBA's activity is limited to bauxite.

The most significant action taken by the bauxite-producing nations in 1974 was a substantial increase in bauxite taxes. The bauxite levy is not a uniform levy, consistently applied by all members of the IBA. It is a tax that takes different forms from country to country, and sometimes from region to region within a specific country. Most frequently, the bauxite levy comes in the form of a production tax, increasing and decreasing only on the basis of tons mined (e.g., in Jamaica). In this way, the levy rate is constant regardless of the amount of ore mined or the returns from the mining operations. A second form of bauxite levy is a simple profits tax (as is found in Guinea). The more money earned from bauxite production, the more tax the company pays. The last form is that of a royalties tax. Such a levy (used in Australia) is in itself used in different ways, but in general has both some production tax and profit tax characteristics. This was initiated by Jamaica, which legislated a nearly sevenfold increase in its revenue from the ore and established a tax levy based on 7.0% to 8.0% of the U.S. list price of aluminum ingot. Many other bauxite-producing countries have also established or raised taxes. Brazil, which will begin exporting large quantities of bauxite in 1978-79, has to date expressed no desire to agree to the IBA goal of high taxes or for that matter to join the IBA.

The bauxite-supplying countries have required that new mining operations be 51% domestically owned. The Jamaican government recently acquired a controlling interest in the bauxite-mining activities of several U.S. producers in Jamaica. Joint ventures of multinational companies with the participation of state-owned companies in bauxite producing countries are already under way.

Copper

Economics of Copper Processing

Although the input characteristics for first stage copper processing (smelting) and second stage copper processing (refining) are quite different, because of high bulk and weight of unprocessed and semiprocessed copper, putting both smelting and refining close to the ore source usually saves money and energy.

Table 9 shows that copper smelting takes substantially more energy and money than copper refining. Four times as much power is needed to smelt one ton of concentrated copper ore as to refine one ton of smelter copper. The relationship between supplies used as inputs into the two processing stages is quite different. Five times as much money for supplies goes to the smelting stage as to the refining stage, and it takes more labor to smelt than to refine copper. The amount of capital needed to produce one ton of refined copper is approximately one-half that needed to produce a ton of smelter.

There are substantial economies of scale in copper smelting. Smelters are usually constructed such that one smelter has sufficient capacity to accommodate the output of three or more fairly large mines. In the

Table 9

INPUT REQUIREMENTS FOR PRODUCING ONE TON OF REFINED COPPER*

	Power† (MWh)	Labor (hours)	Supplies (dollars)	Amortized Capital and Interest (dollars)
Mining	2.2	8.5	127	85
Concentration	4.6	11.2	109	115
Smelting	7.6	9.0	37	52
Refining	1.9	8.5	7	28
Total	16.3	37.2	280	280

*Based on an "average" production center in the southwestern United States in mid-1977.

†All fuels converted to their electrical energy equivalents.

Source: SRI International

major copper production centers in developing countries, copper concentrate from some of the mines is thus transported relatively short distances to the smelter sites, which are most often very close to the major mines. It is not economical to have smelters in nonmining countries because of high transportation costs. The reason for this is that copper ores, even when concentrated, are bulky and heavy. To transport concentrates to smelters via ocean routes would cost slightly less than 5% of the price of the refined copper.*

Copper refining, on the other hand, does not show important economies of scale because output capacity is increased in small increments--by adding standard, small-volume tanks or refining cells. This operation is neither complex nor especially capital-intensive. The advantage of a processing facility that integrates smelting with refining comes from a reduction in energy needed. With a continuous process, smelted copper is kept hot for refining, eliminating the need to use energy to reheat the metal.

Until recently, many refineries have been sited with the end user in mind. Refineries were built in the developed countries to allow quick response to changing markets. Today, markets for refined copper have accepted standardized refined products. Further, market information is transmitted much more quickly than it used to be, and refineries separated from markets can maintain rapid response rates.

Copper production capacity in principal developing country producers initially included at least some integration (see Table 10). In 1955, all four countries refined at least one-half of their smelted copper.

Tables 11, 12, 13, and 14 show historic and forecast levels of ore, smelted and refined copper production, and refined consumption by major producing country. Chile, Zambia, and Zaire have been most successful in forward processing their mined copper ores. Chile and Zambia process a large fraction of their mined ore at present; Zaire is forecast to substantially increase its degree of forward processing by 1990.

A sharp upward trend is forecast for copper mining in the LDCs because they have almost all the high-grade reserves remaining in the world.

The share of smelter production by developing countries is forecast to increase substantially by 1990. There are four basic reasons for this. First, some developing countries have enacted policies to restrict exports of copper ores giving foreign investors in mines an incentive to invest in smelters. For example, Chile, Mexico, and Peru have implemented export taxes on less processed output.

Second, some developing countries have enacted policies that restrict the repatriation of profits to encourage foreign investors in mines to

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*About $0.03 per pound in 1978.

Table 10

COPPER PRODUCTION IN ZAMBIA, CHILE, ZAIRE, AND PERU, 1955-1990
(Thousands of Metric Tons of Contained Copper)

Production	1955	1960	1965	1970	1975	1980	1985	1990
Zambia								
Mine	359	576	696	684	677	605	625	515
Smelter	348	576	696	683	659	605	625	515
Refinery	180	403	522	581	629	605	625	515
Chile								
Mine	434	532	585	692	828	920	1,270	1,520
Smelter	406	505	558	647	724	820	1,150	1,490
Refinery	241	226	289	461	535	740	1,100	1,450
Zaire								
Mine	235	302	289	389	495	510	510	560
Smelter	232	302	289	386	463	480	480	520
Refinery	115	145	152	190	226	360	360	480
Peru								
Mine	43	184	180	212	174	440	560	720
Smelter	32	164	158	176	156	400	480	640
Refinery	28	30	43	36	53	340	360	540

Sources: Metallgesellschaft for 1955 through 1975; SRI International for 1980 through 1990

Table 11

MINE PRODUCTION OF COPPER
(Thousand Metric Tons of Contained Copper)

	Historic					Projected		
	1955	1960	1965	1970	1975	1980	1985	1990
Developed countries								
Americas								
United States	905	980	1,226	1,560	1,280	1,540	1,600	1,760
Canada	296	399	461	610	713	735	735	830
Subtotal	1,202	1,379	1,687	2,170	1,993	2,275	2,335	2,590
West Europe	134	157	183	244	287	375	415	465
East Europe	37	53	80	155	362	575	575	575
USSR	335	500	750	925	1,100	1,140	1,320	1,650
Australia	48	111	92	158	219	205	240	300
Japan	73	89	107	120	85	80	80	80
Total	1,829	2,289	2,899	3,772	4,046	4,650	4,965	5,660
Developing countries								
Americas								
Chile	434	532	585	692	828	920	1,270	1,520
Peru	43	184	180	212	174	440	560	720
All others	78	82	84	85	91	240	460	580
Subtotal	555	798	849	989	1,093	1,600	2,290	2,820
Africa and Mid-East								
Zambia	359	576	696	684	677	605	625	515
Zaire	235	302	289	389	495	510	510	560
All others	69	105	136	212	263	290	245	395
Subtotal	663	983	1,121	1,285	1,435	1,405	1,380	1,470
Asia - Oceania	65	172	196	324	722	735	1,115	1,525
Total	1,283	1,953	2,166	2,598	3,250	3,740	4,785	5,815
Grand total	3,112	4,242	5,065	6,370	7,296	8,390	9,750	11,475

Sources: Metallgesellschaft for actual figures; SRI for projected figures

Table 12

SMELTER PRODUCTION OF COPPER
(Thousand Metric Tons of Contained Copper)

	Historic					Projected		
	1955	1960	1965	1970	1975	1980	1985	1990
Developed countries								
Americas								
United States	1,004	1,119	1,325	1,561	1,313	1,500	1,665	1,965
Canada	257	361	385	465	496	670	700	700
Subtotal	1,261	1,480	1,710	2,026	1,809	2,170	2,365	2,665
West Europe	198	333	434	566	512	730	810	905
East Europe	34	62	88	140	371	525	540	540
USSR	335	500	750	925	1,100	1,140	1,320	1,650
Australia	38	72	80	120	180	200	240	300
Japan	82	247	337	606	742	680	680	720
Total	1,948	2,694	3,399	4,383	4,714	5,445	5,955	6,780
Developing countries								
Americas								
Chile	406	505	558	647	724	820	1,150	1,490
Peru	32	164	158	176	156	400	480	640
All others	56	51	55	64	92	270	410	565
Subtotal	494	720	771	887	972	1,490	2,040	2,695
Africa and Mid-East								
Zambia	348	576	696	683	659	605	625	515
Zaire	232	302	289	386	463	480	480	520
All others	44	63	120	211	224	305	345	375
Subtotal	624	941	1,105	1,280	1,346	1,390	1,450	1,410
Asia - Oceania	18	84	109	139	244	450	755	1,265
Total	1,136	1,745	1,985	2,306	2,562	3,330	4,245	5,370
Grand total	3,084	4,439	5,384	6,689	7,276	8,775	10,200	12,150

Sources: Metallgesellschaft for actual figures; SRI for projected figures

Table 13

REFINED COPPER PRODUCTION
(Thousand Metric Tons of Contained Copper)

	Historic					Projected		
	1955	1960	1965	1970	1975	1980	1985	1990
Developed countries								
Americas								
United States	1,436	1,643	1,957	2,034	1,609	1,935	2,150	2,450
Canada	263	378	394	493	529	605	770	840
Subtotal	1,699	2,021	2,351	2,527	2,138	2,540	2,920	3,290
West Europe	847	985	1,164	1,320	1,383	1,330	1,465	1,635
East Europe	72	90	136	192	432	610	630	640
USSR	430	610	875	1,075	1,420	1,310	1,520	1,900
Australia	39	84	93	146	193	205	245	300
Japan	113	248	366	705	819	850	850	900
Total	3,200	4,038	4,985	5,965	6,385	6,845	7,630	8,665
Developing countries								
Americas								
Chile	241	226	289	461	535	740	1,100	1,450
Peru	28	30	43	36	53	340	360	540
All others	37	31	49	73	100	295	560	650
Subtotal	306	287	381	570	688	1,375	2,020	2,640
Africa and Mid-East								
Zambia	180	403	522	581	629	605	625	515
Zaire	115	145	152	190	226	360	360	480
All others	15	12	32	99	118	235	290	410
Subtotal	310	560	706	870	973	1,200	1,275	1,405
Asia - Oceania	20	110	123	148	322	282	605	1,140
Total	636	957	1,210	1,588	1,983	2,857	3,900	5,185
Grand total	3,836	4,995	6,195	7,553	8,368	9,702	11,530	13,850

Sources: Metallgesellschaft for actual figure; SRI for projected figures

Table 14

REFINED COPPER CONSUMPTION
(Thousand Metric Tons of Contained Copper)

	Historic					Projected		
	1955	1960	1965	1970	1975	1980	1985	1990
Developed countries								
Americas								
United States	1,363	1,225	1,846	1,854	1,396	2,288	2,570	2,920
Canada	126	107	209	229	196	264	290	320
Subtotal	1,489	1,332	2,055	2,083	1,592	2,552	2,860	3,240
West Europe	1,469	1,921	2,178	2,479	2,414	2,952	3,275	3,670
East Europe	115	150	213	305	475	525	570	625
USSR	395	652	783	985	1,200	1,345	1,510	1,710
Australia	52	72	102	113	125	115	130	150
Japan	105	304	428	821	822	1,180	1,420	1,720
Total	3,625	4,431	5,759	6,786	6,628	8,669	9,765	11,115
Developing countries								
Americas								
Chile	35	13	73	21	27	n/a	n/a	n/a
Peru	--	1	2	4	11	n/a	n/a	n/a
All others	46	76	92	159	275	510	815	1,235
Subtotal	81	90	167	184	310	510	815	1,235
Africa and Mid-East								
Zambia	2	1	--	--	2	n/a	n/a	n/a
Zaire	--	1	3	1	2	n/a	n/a	n/a
All others	20	29	42	47	84	134	185	255
Subtotal	22	31	45	48	88	134	185	255
Asia - Oceania	37	185	190	270	468	530	675	875
Total	140	306	402	502	866	1,174	1,675	2,365
Grand total	3,765	4,737	6,161	7,288	7,494	9,843	11,440	13,480

Sources: Metallgesellschaft for actual figures; SRI for projected figures

reinvest in smelters. The decision by the Southern Peru Copper Company to build a copper smelter in Peru serves as an example.

Third, the bulk and weight of copper concentrates still cause copper smelters to be located near mines to save transportation costs, especially for medium- and low-grade ore mines.

Fourth, smelters emit substantial air pollution and DCs have enacted environmental policies that have increased the costs of smelter construction and operation. The analysis of environmentally required capital and operating costs in U.S. indicate that they add from 5-14¢ per pound to the price of refined copper. Developing countries, on the other hand, have not yet imposed additional costs for pollution control.

The share of refined copper production by developed countries has increased substantially over the past 20 years and is forecast to continue to increase through 1990. During the historical period, large integrated plants such as Kennecott in Chile and N.C.C.M. and R.C.M. in Zambia were introduced. These, and other companies were nationalized in the late 1960s and early 1970s. Subsequently, there was a substantial expansion of forward processing by the nationalized industries in Peru, and a lesser expansion in the nationalized industries of Zambia and Zaire. The increase in relative refinery production by developing countries is likely to continue because of policies adopted by producing countries, such as export controls or taxes imposed on smelter copper (e.g., Chile, Peru, Mexico). The nationalized Zambian and Zaire industries have chosen to refine their blister copper as a matter of policy.

Industry Structure

The copper industry is characterized by two types of producers: the vertically intergrated companies and the custom smelters and refiners. The integrated group is active in every stage of copper production, from exploration through the output of refined copper and copper semis. This group includes the large government mining companies as well as the traditional copper producers.

The custom group relies on purchased raw materials and the toll processing of customer materials. Some of the largest refiners in the world fall into this class of producers.

There has been a trend toward government ownership and control of the copper industry throughout the world. The mechanisms used by government include:

- Outright control--USSR, Chile (CODELCO).
- Government ownership with private company operator (service contract), with equity participation (Panama/Texasgulf) or without (Iran/Anaconda), Zaire (GECAMINES).

- Government majority participation--Zambia (MINDECO).
- Government minority participation--Brazil.

In all cases, government has further control by requiring national equity (Mexico), or in the granting of export licenses (Australia). While all of these forms of control are expected to increase in the future, it appears that the service contract mechanism will become more favored as a means of reconciling the desire for nationalism and the requirements of economic pragmatism.

Iron Ore, Iron, and Steel

Economics of Processing

The requirements and characteristics of processing iron ore differ considerably from those of processing bauxite and copper. First, both bauxite and copper ore go through two processing stages: bauxite has refining (alumina production) and smelting (aluminum production) stages, and copper has smelting (producing blister) and refining (producing cathode) stages. These processes for the two minerals can be (and often are) performed at different locations. Iron ore, on the other hand, is typically processed into pig iron and then steel at one location.

Second, whereas there is substantial demand in the DCs for copper and aluminum produced by LDCs, the industrialized countries import only very small amounts of LDC steel. There are several reasons for this. One reason is that producing high-quality steel requires know-how and precision. It is generally believed that LDCs produce steel products that are of an inferior quality to DC steel products. Another reason is that many large, integrated companies own and/or operate iron ore mines in developing countries, such that the imported iron ore feeds directly into their DC-based steel facilities. Legal ownership and marketing arrangements support this type of mining and processing structure. Further, many steel plants located in the developed countries operate at less than capacity. It is in the interests of the owners of the steel plants to keep operating levels high, thus reducing the marginal cost of their output. A multinational company having excess capacity in one location would not want to build additional capacity in a new location unless the cost-price structure substantiated such an action. Current market conditions do not appear to favor MNC building of steel plants in LDC iron ore mining countries.

Third, multinational companies historically have not played substantial roles in iron and steel production in developing countries. This is because iron ore processing has been taking place in LDCs for a longer period than have copper and bauxite processing. Especially in their early years, multinational corporations were not as competitive in iron ore processing as in the processing of other minerals. Multinationals often exploit their ability to invest very large sums by focusing on capital-intensive industries where the entry level investment requirement tends to discourage competition. Accordingly, as the forward processing of iron ore is less capital intensive than the forward processing of bauxite and copper, ceteris paribus MNCs would have a competitive advantage in the processing of bauxite and copper over the processing of iron ore.

There are a few economic factors which sometimes make it difficult for LDCs to produce steel at or below the world market price for the product. Because an integrated operation uses less energy than a nonintegrated operation, the lowest cost method of producing steel is usually through an integrated steel mill. Such a facility requires a large initial investment and is most economical when operated on a large scale. To run an integrated steel mill at or above the break-even level, a developing country would need adequate financial resources and a market for its product, but

the market is difficult for LDCs to obtain. Developed countries have not and are not expected to buy more than insignificant quantities of steel produced in developing countries. Further, the developing country markets for steel are most often very small in those LDCs which do not produce their own steel. Production of steel in developing countries thus appears most likely to increase or develop in those developing countries which have indigenous demand for the product. Through 1990, the largest LDC steel producers will be Brazil, Mexico, India, and Venezuela. All of these countries with the exception of Mexico will process their own iron ore into steel (see Tables 15, 16, and 17).

Table 15

IRON ORE PRODUCTION
(Millions of Metric Tons)

	Actual					Projected		
	1955	1960	1965	1970	1975	1980	1985	1990
Developed countries								
North America								
United States	104.6	89.0	89.2	91.2	81.4	95	105	110
Canada	15.8	19.6	34.2	47.5	39.6	60	65	70
Subtotal	120.4	108.6	123.4	138.7	121.0	155	170	180
West Europe	119.1	147.9	139.6	138.3	115.6	90	80	70
East Europe	7.3	9.3	12.1	11.3	14.0	10	10	10
USSR	71.9	105.8	153.7	195.0	232.8	255	301	379
Australia	3.6	4.4	6.8	51.1	99.4	110	140	170
Japan	1.5	1.9	2.5	1.6	0.9	1	1	1
Total	323.8	377.9	438.1	536.0	583.7	621	702	810
Developing countries								
Latin America								
Brazil	4.1	9.3	16.0	30.0	69.6	90	123	160
Mexico	0.7	0.9	2.5	4.8	5.6	5	5	5
Venezuela	8.4	20.1	17.7	22.0	27.0	30	32	35
All others	4.1	12.2	19.2	21.9	20.9	20	25	30
Subtotal	17.3	42.5	55.4	78.7	123.1	145	185	230
Africa and Middle East	12.0	15.5	38.9	60.3	72.0	76	100	140
Asia, including Oceania								
India	6.1	16.5	23.4	31.4	40.3	40	45	50
All others	12.6	65.8	65.4	58.3	62.4	60	70	90
Subtotal	18.7	82.3	88.8	89.7	102.7	100	115	140
Total	48.0	140.3	183.1	228.7	297.8	321	400	510
Total world	371.8	518.2	621.2	764.7	881.5	942	1,102	1,320
Share of developing countries as percent of total	13	27	29	30	34	34	36	39

Sources: Metallgesellschaft for actual figures; SRI International for projected figures

Table 16

PIG IRON PRODUCTION
(Millions of Metric Tons)

	Actual					Projected		
	1955	1960	1965	1970	1975	1980	1985	1990
Developed countries								
North America								
United States	71.9	62.2	79.8	83.3	73.8	106.0	105.0	114.0
Canada	3.1	4.0	6.0	8.2	9.2	11.0	14.0	17.0
Subtotal	75.0	66.2	85.8	91.5	83.0	117.0	119.0	131.0
West Europe	59.2	78.7	92.5	113.4	104.5	141.0	152.0	170.0
East Europe	8.9	13.5	18.5	23.8	32.2	38.0	52.0	71.0
USSR	33.3	46.8	66.2	85.9	102.4	116.0	146.0	173.0
Australia	1.9	2.9	4.3	6.1	7.6	8.0	9.0	12.0
Japan	5.4	12.3	28.2	68.0	86.6	93.0	100.0	102.0
Total	183.7	220.4	295.5	388.7	416.3	513.0	578.0	659.0
Developing countries								
Latin America								
Brazil	1.1	1.8	2.5	4.2	7.0	7.5	12.2	23.3
Mexico	0.3	0.7	1.0	2.3	3.2	3.1	6.2	10.7
Venezuela	--	--	0.3	0.5	0.6	0.8	1.2	1.5
All others	0.4	0.7	1.2	1.6	2.0	3.4	10.5	15.3
Subtotal	1.8	3.2	5.0	8.6	12.8	14.8	30.1	50.8
Africa and Middle East	1.4	2.1	4.1	4.5	5.7	8.0	10.0	14.0
Asia, including Oceania								
India	1.9	4.3	7.1	7.0	8.2	9.3	10.0	12.1
All others	4.0	28.5	15.5	18.8	26.2	30.8	50.8	81.2
Subtotal	5.9	32.8	22.6	25.8	34.4	40.1	60.8	93.3
Total	9.1	38.1	31.7	38.9	52.9	62.9	100.9	158.1
Total world	192.8	258.5	327.2	427.6	469.2	575.9	678.9	817.1
Share of developing countries as percent of total	5	15	10	9	11	11	15	19

Sources: Metallgesellschaft for actual figures; SRI International for projected figures

Table 17

STEEL PRODUCTION
(Millions of Metric Tons)

	Actual					Projected		
	1955	1960	1965	1970	1975	1980	1985	1990
Developed countries								
North America								
United States	106.2	90.7	119.0	119.3	105.8	146.0	159.1	177.1
Canada	4.1	5.3	9.1	11.2	13.0	16.0	19.8	24.4
Subtotal	110.3	96.0	128.1	130.5	118.8	162.0	178.9	201.5
West Europe	79.3	100.5	129.4	162.0	154.9	195.1	214.1	242.1
East Europe	13.9	21.2	28.6	40.1	51.3	64.4	81.0	101.3
USSR	45.3	65.3	91.0	115.9	141.3	153.8	182.7	211.2
Australia	2.2	3.8	5.6	6.9	7.9	8.6	10.5	13.7
Japan	9.4	22.1	41.2	93.3	102.3	125.4	133.7	136.6
Total	260.4	316.9	423.9	548.7	576.5	709.3	800.9	906.4
Developing countries								
Latin America								
Brazil	1.2	2.3	3.0	5.4	3.3	10.8	16.2	28.6
Mexico	0.5	1.5	2.5	3.7	5.3	6.1	10.0	16.2
Venezuela	--	--	0.6	0.9	1.1	2.8	6.0	9.0
All others	0.6	0.4	2.1	2.9	3.7	4.2	12.0	17.0
Subtotal	2.3	4.7	8.2	12.9	18.4	23.9	44.2	70.8
Africa and Middle East	1.7	2.3	3.9	5.9	8.6	19.1	26.5	38.4
Asia, including Oceania								
India	1.7	3.3	6.4	6.3	8.0	10.2	11.7	14.2
All others	3.1	19.4	11.8	22.1	32.1	46.9	75.0	111.6
Subtotal	4.8	22.7	18.2	28.4	40.1	57.1	86.7	125.8
Total	8.8	29.7	30.3	47.2	67.1	100.1	157.4	235.0
Total world	269.2	346.6	454.2	595.9	643.6	809.4	958.3	1,141.4
Share of developing countries as percent of total	3	9	7	8	10	12	16	21

Sources: Metallgesellschaft for actual figures; SRI International for projected figures

III THE EFFECTS OF LESS-DEVELOPED COUNTRY GOVERNMENT POLICIES ON MINERALS PROCESSING

Through the gathering of economic and policy data on various developing countries that both mine and process minerals, it became evident to SRI that policies of LDCs can and have influenced the level of investment in local minerals extraction and processing. Close and comparative examination of the data led to the conclusion that some policies appeared substantially more influential than other policies. Conclusions reached regarding relative levels of importance of the various policies are thus based on the examination of the available data and on the professional judgment of SRI staff. The following is the general classification of relevant policy variables:

- The stage of maturity of the minerals project
- The level of return of the minerals project
- The type of government policies
- Mineral-specific versus economy-wide policies.

In addition, policy types were further divided into four general categories: monetary and capital, fiscal, labor, and trade and investment policies. Issues of relevance to LDC policies are also included. They are: environmental, technological, regional market, and social benefits versus private returns issues.

Overview

Although any government policy can affect the mineral industries in LDCs, not all policies have a significant effect, and the effect of any one policy changes according to the maturity and profitability of the particular operation. Policies that affect profitability have the strongest effect in the earliest stages of a minerals processing project (planning, negotiation, and preparation) and less effect in later stages (construction and operation). Policies have a stronger effect on mineral operations whose returns are marginal than on those with adequate or high returns.

Although a favorable government policy environment may be essential in attracting priviate capital in the early planning and negotiation stage, a too favorable policy may at times be a hindrance because it is likely to have elements of instability. Once private capital has been attracted and a plant is in place, slight decreases in profitability can remain acceptable.

Of the various types of policies, those on trade and investment have more effect than those on ownership, and monetary and capital policies have a more immediate effect than labor policies. Finally, although expropriation may halt private investment in an operating mineral industry, it need not halt forward processing.

Policy Effect by Stage of Maturity

Decisions made before any structures or manpower are committed often have a relatively large impact, at least in the short run, on the processing capacity of a specified region. The effect can linger for many years. To the extent that investment in and integration of processing are functions of government policies, the relationship tends to be most direct the earlier it occurs in the stage of project development. If a country in the early years of its development has favorable policies that attract foreign investment within its borders, minor or moderate changes in the country's policies will likely be of only marginal importance. However, when unattractive policies influence the return-risk ratio such that it is just above the minimum level required, any negative changes in the country's policies could bring significant reversals in future investments and operations.* In Zambia and Jamaica the environment for initial minerals processing investment was substantially more favorable than the existing environment.† As the capital and labor infrastructure are already in place in Zambia and Jamaica, these countries have slightly more freedom in modifying policies to reduce the profitability of processing facilities. Mineral companies will operate existing processing plants at rates of returns lower than would be required to put new facilities in the same location. ‡

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*An example of the effects of a change against the interests of the minerals companies in Jamaica is the bauxite production levy. When the companies operating in Jamaica were informed of the new tax, they apparently were not told that it could be deducted from income such that income tax would be paid on income net of the bauxite levy. For every $1.00 increase in the bauxite levy, the companies decreased their income tax liability by an amount somewhat less than $1.00. The full initial and partial subsequent reaction to the new levy was said not to take this into account. The psychological reaction to "a new tax" was greater than the bottom-line effect. The companies were quite angry and complained to the Jamaican Government. World Bank economists noted that it was partially in response to this levy that the minerals companies decided to cut back bauxite and alumina production in 1975.

†The major factors in the current investment environment of Zambia and Jamaica are described beginning on pages 61 and 73, respectively.

‡This argument is put forth by Theodore H. Moran in Multi-National Corporations, The Politics of Dependence: Copper in Chile (Princeton University Press, Princeton, New Jersey, 1974).

Policy Effect by Level of Return

Government policies have the greatest effect where the adequacy of return on a proposed investment is questionable. When the financial rate of return is substantially more than adequate, the investor will not be likely to be very sensitive to minor policy changes, even though these changes may slightly decrease his profitability. On the other hand, when the forecast returns are only slightly above the minimum required level set by the investors, any policy instituted or changed that results in reducing the attractiveness of the investment will have strong effects. For example, if the Jamaican Government wanted to increase its first-stage bauxite processing partially through private funding, it would have to exercise more caution in its choice of new policies or policy changes than would a country that had similar returns (before taxes) on alumina production but had more favorable policies.* Similarly, because Jamaica imposes a bauxite levy (thus reducing rates of returns to bauxite production), the policies of the Jamaica Government have relatively larger impacts than those of other similar countries without such taxes.

Policy Effect by Type of Policy

When the extent and importance of government policies on minerals processing in developing countries are examined, individual policies cannot be considered in isolation. It is the combination of policies that determines the magnitude and type of impact created. Further, the degree of policy stability often overshadows its direction (favorable or unfavorable) in the determination of policy effects. Ernesto Tironi says:†

> Too favorable or unfavorable policies towards foreign companies are intrinsically unstable, and unstable policies neither stimulate investment in the host country nor bring about a higher surplus from the exploitation of natural resources.

It is evident when reviewing policies in Chile that investors often tend to prefer policies that are stable but mildly adverse to policies that on average are more favorable but highly variable. Realizing this, the Government of Chile, in its Foreign Investment Statute of 1977, gives a foreign investor the option of being subject either to the tax code for

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*The favorable policies in the other country would have the effect of reducing risk (compared with the risk in Jamaica) and/or increasing returns through lower tax rates (compared with the tax rates in Jamaica).

†Ernest Tironi, "Problems of Resource Rich Less Developed Countries: Copper in Chile," unpublished draft paper presented to the Ninth Pacific Trade and Development Conference, August 22-26, 1977, San Francisco, California.

nationals (which can be changed at any time) or to the existing tax code, which is guaranteed frozen for the life of the investment. Foreign companies are apparently pleased with this and other investment code provisions as they have recently begun to make new investments in the country.*

Mineral-Specific Versus Economy-Wide Policies

Policies influencing minerals processing are of two types: economy-wide policies (macropolicies) that impact the minerals sector equally with other sectors and mineral-specific policies that place extra burden on or grant special concessions to the minerals industry. Both types of policies have monetary, capital, fiscal, labor, and trade components, and the distinction between the macropolicies and the mineral-specific policies comes from the way the policies are applied. In principle, mineral-specific policies can be changed relatively easily and in the long run do not tend to have constant impacts on the processing industry. Broad-based policies, on the other hand, are not likely to be altered as easily nor to suit the needs of just one or two sectors of the economy.

The typology in Table 18 gives examples of the differences between macropolicies and mineral-specific policies.

Monetary and Capital Policies

The examination of policies in Zambia, Jamaica, and Liberia as they affect existing (or potential) minerals processing industries shows that the most influential set of developing country policies consist of monetary and capital policies (Table 19). In Jamaica, a highly overvalued exchange rate is applied specifically and solely to the transactions of minerals companies. The effect of this action significantly reduces the profitability of bauxite mining and alumina processing. Further, this sole mineral-specific policy is causing a substantial amount of ill will and negotiation difficulties between the Jamaican government and the privately owned companies. In a similar manner, the lack of availability of financing for capital expenditures by copper and other companies in Zambia is severely handicapping copper-processing efforts. With respect to foreign exchange, the Zambian government appears not to be discriminating in favor of or against the 51% publicly owned minerals companies. Its foreign exchange policies are applied about equally to all sectors of the economy. Loan guarantee policies of the Zambians are mineral-specific in nature and have the result of directly raising the cost of copper company borrowing.

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*Recent purchases of Chilean mines by American-based Exxon Corporation and Canadian-based Noranda Corporation exemplify this fact.

Table 18

LESS-DEVELOPED COUNTRY POLICY ANALYSIS TYPOLOGY

	Examples of Macroapplication	Examples of Mineral-Specific Application
Monetary and capital policies		
Exchange rate	How should the exchange rate be set?	Should the exchange rate discriminate against or in favor of mineral industries?
Borrowing and credit	Is the supply of funds available for credit sufficient?	Should the government reduce the cost of credit by giving loan guarantees to the mineral sector?
Fiscal policies		
Infrastructure	How should the government spend its funds to build infrastructure?	Through what channels can the government best provide infrastructure particularly suited to further mineral processing?
Subsidies	Should any portion of the economy be subsidized?	Should the minerals industry in particular be subsidized?
Income tax	At what rate should an income tax be applied?	Should minerals companies be taxed at a rate different from other companies?
Labor policies		
Training	How should the government help schools and universities to adjust their programming to meet the needs of the economy?	Under what circumstances should the government specifically encourage increased capacity for the training of minerals processing managers or laborers
Wages	Should minimum wages be established?	Should a different minimum wage be set for minerals company employees?
Trade and investment policies		
Quantitative restrictions and nontariff barriers	What types of restrictions should be placed on importing and exporting goods and services?	When should restrictions and barriers be different for the minerals industry than for other sectors?
Ownership	How should a distinction be made between when private ownership is or is not appropriate?	Should minerals activities be treated differently from other activities in the economy?

Table 19

MAJOR MONETARY AND CAPITAL POLICIES THAT PROMOTE AND INHIBIT MINERALS PROCESSING

Policies That Promote Processing	Policies That Inhibit Processing
Setting exchange rate to reflect true scarcity value	Overvaluing exchange rate Setting discriminatory (e.g., dual exchange rate policies)
Freely convertible currency	Heavy restrictions on currency conversion
Government guarantees on loans to mineral processing companies	Guarantees not available or available only for exhorbitant fees
Easy repatriation of capital and profits	Restricted repatriation of capital and profits

Fiscal Policies

In addition to monetary and capital policies, mineral-specific and economy-wide fiscal policies can also have strong impacts on LDC minerals processing (Table 20). Included in this category of policies are export and production taxes as well as import duties. Government revenue collection and expenditure policies have a direct, bottom-line significance to minerals processors. Their effects on profitability and production are felt very quickly and can have great psychological as well as actual results.

Table 20

MAJOR FISCAL POLICIES THAT PROMOTE AND INHIBIT MINERALS PROCESSING

Policies That Promote Processing	Policies That Inhibit Processing
Reduce or eliminate taxes on import duties and on production (export and ad valorem taxes)	Increase taxes on inputs (import duties) and on production (export and ad valorem taxes)
Grant investment tax credits, tax holiday, depletion allowance	Not grant even minor tax relief or special concessions

Labor Policies

Another category of important policies influencing the degree of processing in developing countries is labor policies (Table 21). As will be shown in the case study of Zambia (pages 61-71), inadequate and/or improper policies with regard to training nationals to operate processing facilities are presenting impediments to the operations of the Zambian plants. Labor policies operated in Zambia's favor in the 1960s. This can be seen by comparing Zambia's processing situation with that of Zaire. Zambia and Zaire both have high-grade copper deposits, and both have inexpensive power (they share the Lake Kariba hydroelectric power project on the Congo River). Zambia has progressed much further in forward processing than Zaire, in part because Zambia encouraged immigration of foreign skilled managers and laborers, particularly those associated with the British companies. Zaire, on the other hand, has expanded forward processing since the Belgians left in the late 1960s, but has not been as successful as Zambia, in part because they have tried to use less foreign management and technical help. Thus, despite similar basic economic prerequisites, Zambia has made much greater progress than Zaire in forward processing partly because of its acceptance of foreign labor.

Contrary to monetary capital and fiscal policies, labor policies generally require a relatively long period before their impacts are felt and integrated. This is because it takes many years to educate, train, and integrate individuals who are initially unfamiliar with mineral-related activities. Additionally, the impact of labor policies on the availability of expatriates tends to be variable, as political factors in the host country as well as neighboring countries can be of the utmost importance to many individuals.

Table 21

MAJOR LABOR POLCIES THAT PROMOTE AND INHIBIT MINERALS PROCESSING

Policies That Promote Processing	Policies That Inhibit Processing
Funding for appropriate education and training of minerals engineers, geologists, and other earth-science professionals	Education and training as low priority
Requiring dissertations of Ph.D. students to contribute to knowledge in the minerals-processing sector of the country	
Encouraging expatriates to keep positions through lower tax rates, reduction in repatriation of salary restrictions, etc. until nationals are adequately trained	Hostile environment toward expatriates, including extra heavy taxation, political threat

Trade and Investment Policies

In examining the three countries for which case studies are presented, no evidence was found that LDC trade and investment policies are relatively important (Table 22). Trade policies consisting of tariffs, quantitative restrictions (such as quotas), nontariff barriers, and export/import subsidies or taxes have just minor (and at time undiscernible) impacts on minerals processing in the LDCs.* In general, the same can be said for most of the LDC investment policies. Concessions agreements and arrangements regarding royalties and depreciation are not found to be important determinants of the amount of minerals processing. Less information was available on these types of policies, and the available information did not support strong or substantial linkages between trade and most investment policies and the level or extent of minerals processing.

Table 22

MAJOR TRADE AND INVESTMENT POLICIES THAT PROMOTE AND INHIBIT MINERALS PROCESSING

Policies That Promote Processing	Policies That Inhibit Processing
Low or zero levels of duties on goods and services used as inputs into processing and mining activities	High levels of duties on goods and services used as inputs into processing and mining activities
Low or zero levels of quantitative restrictions and nontariff barriers	High levels of quantitative restrictions and nontariff barriers
Subsidies applied to goods exported	Taxes applied to goods exported
Concession agreements which leave the minerals companies substantial independence	Concession agreements which require a large amount of government supervision and/or approval of minerals operations
Ownership in the hands of those who have sufficient managerial and operational expertise, and access to capital	Ownership in the hands of those who have neither the skills nor the capital to run the processing facilities adequately

*Chile, Peru, and Mexico currently have an export tax on blister. Such taxes in these copper-mining countries have tended to increase relative copper refinery production in these countries.

The effects of one type of investment policy--ownership--are more substantive, however. In Zambia there is a direct link between majority public ownership of the integrated Zambian copper production facilities and the availability of internal and external capital. Only in this one case was an investment policy shown to be relatively important.

Expropriation Policies

Expropriation policies inhibit private sector involvement in processing, but this does not mean that they have the net result of inhibiting forward processing of minerals in developing countries. All types of expropriation of mines and processing plants, whether or not adequate compensation is provided, substantially increase the rates of return which prospective private sector investors require. This is simply because the higher the likelihood of expropriation, the higher is the level of risk associated with the investment; and companies seek more reward for each increment of risk which they see. The effects of expropriation are not necessarily detrimental to minerals processing. Zambia nationalized its copper industry in 1969, but there have been few harmful effects. The Zambian Government since nationalization has essentially been a figurehead. It has allowed the same two British companies which previously owned the operations to operate with an adequate financial return under management and sales contracts. If the LDC either is indifferent to private funds in the minerals sector or specifically desires only public funding of processing, it is possible that expropriation can increase the quantity of processing and the returns to processing, provided that funds are available to the public sector.

In practice, expropriation has often had many deleterious effects on minerals processing in developing countries. The reasons for this have been complex and often have included inadequate public sector access to credit* and strong efforts to put less knowledgeable nationals in positions previously staffed by expatriates (as is the case in Zambia). Expropriation itself, however, does not necessarily have to be harmful to the processing industry in the specified country. Moreover, if the minerals industries are privately owned, significant operational and other difficulties could arise as a result of differences of opinion between public and private sectors of the economy (as is the case in Jamaica). Furthermore, in LDCs that have no history of and a close to zero likelihood of expropriation, minerals can still be exported in raw or semiraw form (as is the case in Liberia). In the countries examined, expropriation was not found to significantly affect the level of minerals processing. In the long run, however, expropriation probably will lead to reduced foreign investment and processing in LDCs.

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*This includes both reduced amounts of credit availability and granting of credit at higher interest rates.

Summary

Monetary and capital, fiscal, labor, and investment and trade policies in LDCs have widely varying effects on the countries' minerals sectors. To determine the extent of a country's economy-wide or mineral-specific policies on processing, it is best to examine the individual country in detail. A few generalizations can, however, be made.

In most developing countries, private foreign involvement in minerals extraction and processing is often at least a prerequisite to the development of the minerals sector. The sums of money required for projects of this type are normally so large that public funds, even those available in relatively large amounts (such as those of the International Bank for Reconstruction and Development), are inadequate. If an LDC wants to process its minerals either in the present or in the near future, it is often to the country's advantage to have amiable relations with private corporations. The LDC can do this in part through a set of policies which are attractive (or at least not unattractive) to private interests. It was found that mineral-specific policies can be as important as economy-wide policies and that the relative impacts of different policies can be ranked. In order of decreasing importance, these are:

- Monetary and capital policies
- Fiscal policies
- Labor policies
- Trade and investment policies.

There are, nevertheless, many instances where governments' mineral-specific or economy-wide policies are not enough to overcome other types of competitive advantages. A case in point is the siting of aluminum plants, which are becoming increasingly spread around the world. The major reason for this is that electrical energy is responsible for a large part of the costs for smelting aluminum, and accordingly, aluminum plants are increasingly sited near less costly energy sources. Several countries that do not mine bauxite or process alumina are using imported alumina to smelt aluminum. Among them are new smelters in such places as Indonesia, Iran, Saudia Arabia, Ghana, and Venezuela.

Other Issues

There are several issues of relevance to LDC policies that can have substantial impacts on minerals processing in developing countries. Four of these are discussed below. They are: environmental, technological, regional market, and social benefits versus private returns issues.

Environmental Issues

Pollution control costs can substantially affect costs of forward processing of some minerals. During the last decade, DCs have attempted to reduce pollutants resulting from industrial activities, concomitantly increasing both operating and capital costs of new and existing plants. The Bureau of Economic Analysis reported that in 1976 the mining industry in the United States spent $86 million of its new plant and equipment expenditures for pollution abatement (see Table 23). This is an increase of 18% over the 1975 level of $73 million. Planned 1977 pollution abatement expenditures were almost double the 1975 level at $130 million.

Table 23

NEW PLANT AND EQUIPMENT EXPENDITURES BY U.S. BUSINESS:
TOTAL AND FOR POLLUTION ABATEMENT
(Millions of Dollars)

	1975		1976		Planned 1977	
	Total	Pollution Abatement	Total	Pollution Abatement	Total	Pollution Abatement
All industries	113,489	6,549	121,232	6,762	134,953	7,512
Mining	3,823	73	3,972	86	4,409	130

Source: Frank W. Segal and Betsy C. Dunlap, "Capital Expenditures by Business for Pollution Abatement, 1976 and 1977 Planned," Survey of Current Business, Vol. 57, No. 6, pp. 13-15 (June 1977)

Costs resulting from environmental regulations have been particularly pronounced in the production of steel and copper smelting, but have been less pronounced in aluminum production.

The steel cycle generates substantial air and water pollution. Coke ovens, required for blast furnaces, are large polluters. Pollution control equipment costs for steel companies have been substantial. (For example, U.S. Steel is planning a new plant with an annual capacity of 3 million tons in Conneaut Lake, Ohio. Of the total estimated capital costs, 15% is for pollution control.) Expenditures for new pollution abatement equipment in the blast furnace/steel works industry were substantially in excess of the all-industry average when measured as a percentage of total plant and equipment expenditures. Whereas the steel works/blast furnace business spent 16% of new capital expenditures for pollution abatement, all U.S. industries on average spent only 5.6% (see Table 24).

Table 24

POLLUTION ABATEMENT EXPENDITURES
AS A PERCENTAGE OF NEW PLANT AND EQUIPMENT EXPENDITURES
1976-1977
(Millions of Dollars)

	1976 Actual	1977 Planned
All industries	5.6	5.6
Nonferrous metals	19.0	17.0
Blast furnaces, steel works	16.0	19.0

Source: U.S. Department of Commerce, Bureau of Economic Analysis

Copper smelters emit substantial air pollution. Analysis of actual environmentally required capital and operating costs in the United States indicates that pollution control may add 5¢ to 14¢ per pound to the price of refined copper.

The LDCs have not yet approached pollution control with the vigor of the DCs.* Moreover, many minerals economists state the LDCs even welcome pollution-generating industry so long as the industries provide some jobs and foreign exchange.

Relative pollution control costs (especially for steel) can substantially affect total costs of processed minerals between LDCs and DCs. Thus, if the developed countries continue to tighten their pollution control regulations and substantially increase the cost of steel production vis-à-vis costs in LDCs, a definite competitive advantage will be provided to those LDCs without strict pollution control policies.

Technological Issues

SRI is not aware of any new technologies in the production of copper, aluminum, or steel that would make developing countries substantially more competitive in international markets within the next decade. Expected advancements in technology may even work to the detriment of LDC processors because some technology will be even more capital-intensive (and less labor-intensive) than existing operations. None of the forecast new technologies will provide major positive benefits to LDCs.

*Of all the DCs, Japan has the strictest pollution control requirements; the United States is second, with Europe being the most lenient.

Alumina--Investigations are under way to permit better evaluation of alumina recovery processes from ores other than bauxite. Although the current industrial use of nonbauxite ores in the production of aluminum in the USSR is significant, such production techniques exist but are limited in other parts of the world.* Alumina recovery (outside of the Soviet Union) is generally uneconomic when compared with present operations for the recovery of alumina from bauxite. A major reason for this is that alumina content in the other minerals is usually lower than that in bauxite.

It is possible that at some future date alumina recovery from other ores could become more economical.† As deposits of many of the nonbauxite alumina sources are prevalent throughout the world, LDCs could potentially benefit from the changing economics. Success of recovery processes using alternative ores would affect only the new alumina production facilities built to use the other ores. Bauxite would still be required for today's operating plants and others constructed in the intervening years. On the basis of existing cost estimates, alternative alumina-recovering ores appear unlikely to become a major source of raw materials in the near future.

Aluminum--Since the mid-1960s, several methods have been devised for the replacement of the standard aluminum metal production process (the Hall-Heroult process). Some of these methods are in the laboratory stage, and others are in pilot stage.‡ They seek in part to reduce energy usage in aluminum production by from 5% to 30%. Even if such processes prove technically and economically feasible, the production of aluminum will still be very energy-intensive, and the basic economics of aluminum processing as discussed earlier in this report will not change dramatically.

Copper--Technical developments likely to affect the supply of copper in the near future will take place in underground mining technology, beneficiation, smelting, and hydrometallurgical processing. The potential impact of each of the changes varies with the particular development, but in no case will the developments substantially affect the competitive position of LDCs in copper processing.

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*Alumina is recovered from clay in Germany; from alunite, clay, and shales in Japan and the United States; and from fly ash in Poland.

†This could occur, for example, if bauxite taxes or royalties were increased dramatically, or if nonbauxite production technologies improved.

‡Alcoa has built a plant to produce 27,000 tons of metal per year, using a process that reduces the electrical energy requirement by about 30%. This process will continue to require alumina as the raw material feed.

Significant improvements in underground mining techniques are becoming widespread as underground costs increase. These improvements include mechanized drilling, the use of load/haul/dump equipment in trackless working, tunneling and boring techniques, roof reinforcement, and underground communications. In smelting, the combined effects of required pollution control and energy prices indicate a phasing out of the standard reverberatory furnace. The newer practices include changes in furnace design and in the process itself toward a continuous process that combines smelting and converting.

The use of hydrometallurgy has expanded such that it is considered as an alternative to conventional beneficiation-smelting-refining. In many cases, it can offer cost advantages for small- and medium-scale operations because of its low capital requirements. However, the economics of this process provide an incentive only if the physical conditions of the material and infrastructure permit. This is not expected to be the case for many new copper developments within the next decade.

Iron and Steel--There appear to be no new technological factors that would significantly affect the position of LDCs in the processing of iron ore. Evolutionary changes in iron ore production methods and processes are expected in the long run. The trends toward larger equipment and larger scaled mining and beneficiation operations will continue, with pellets providing an ever-increasing proportion of iron ore supply. Similarly, the production of metallized ore by various direct reduction processes is likely to increase significantly, possibly approaching nearly one-tenth of all iron ore production by the year 2000.

Regional Market Issues

Regional marketing agreements or tariff agreements have often been considered to be beneficial, at least in theory, to the development of lower-income countries. A major reason for interest in regional markets is the small size of markets in many countries. Many development economists agree that economic groupings larger than the nation state are needed to promote rapid economic development and to secure greater equality in international economic bargaining. The first United Nations conference on Trade and Development (UNCTAD) stated:

> Regional economic groupings, integration or other forms of economic cooperation should be promoted among developing countries as a means of expanding their intra-regional and extra-regional trade and encouraging their economic growth and their industrial and agricultural diversification with due regard to the special features of development of the various countries concerned as well as their economic and social systems.*

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*Source: United Nations Conference on Trade and Development, Proceedings, Vol. 1: Final Act and Report (New York, 1964), p. 11

More than a dozen customs and monetary unions, common markets, free trade zones, and other regional cooperative arrangements have been proposed or established in the developing nations of Latin America, Asia, and Africa. Some of the cooperative efforts, such as those proposed for West Africa, never reached fruition. Others were dismantled at early stages for political reasons--e.g., the Federation of Rhodesia and Nyasaland and the Rwanda-Burundi customs and monetary union. Several are in existence, however, and continue to be at least moderately successful (e.g., Latin American Free Trade Association and the Andean Group).

Regional markets would help to foster minerals processing in developing countries if they increased the markets for LDC-processed minerals. But the ability of LDCs to increase their forward processing of minerals depends not only on the markets for the minerals, but also on the production of the mineral ore. The relevant question to ask with regard to forward processing and regional markets is: Will regional markets provide impetus for further LDC minerals processing? Each metal is examined briefly in terms of current and future mining production and consumption to estimate the potential impact of regional markets on the amount of developing country forward processing.

Aluminum--About 50% of bauxite is mined in LDCs although these countries only account for about 8% of aluminum production and consumption. As shown in Table 25, most regions of the world tend to produce about the same percentage of the world's aluminum as they consume, and this general pattern is projected to continue at least through 1985. To a large extent, the market for aluminum is in the DCs. Nevertheless, LDCs are projected to increase their share of world aluminum consumption from about 8% in 1975 to 12% in 1985.

Copper--As with aluminum, LDC consumption of copper products is not currently large relative to total world demand. LDCs in 1975 produced about 22% and consumed about 10% of world copper. This situation is forecast to change somewhat by 1990. The Latin America region is projected to increase their copper production by over 100%, from 7% of the world total in 1975 to 19% in 1985. Their copper consumption will grow from 4% to 9% in the same period (see Table 26). Less growth is also forecast for the other two main regions with developing countries. By 1990, the Latin America, Africa, and Middle East regions are expected to process between 75% and 80% of their copper ores, and Asia is expected to process somewhat over 60% of its ore. These figures correspond to about 50% of copper ores being processed locally in 1975.

Table 25

DISTRIBUTION OF BAUXITE MINING AND OF ALUMINUM PRODUCTION AND CONSUMPTION BY REGION
(Percentage of World Total)

	1974-1975			1985		
	Bauxite Mining	Aluminum Production	Aluminum Consumption	Bauxite Mining	Aluminum Production	Aluminum Consumption
Western Europe	10	26	25	na	24	24
Eastern Europe	5	4	5	na	4	5
USSR	8	17	11	na	12	11
North America	2	35	40	na	33	34
Latin America	29	2	3	na	7	4
Africa and Middle East	15	3	1	na	4	2
Asia	30	14	15	na	16	20
Excluding Japan and Australia	4	3	4	na	6	6
Japan and Australia	26	11	11	na	10	14

Note: Totals may not add due to rounding.

na = not available.

Source: SRI International

Table 26

DISTRIBUTION OF COPPER MINING, PRODUCTION, AND CONSUMPTION BY REGION
(Percentage of World Total)

	1974-1975			1990		
	Copper Ore Mining	Copper Production	Copper Consumption	Copper Ore Mining	Copper Production	Copper Consumption
Western Europe	4	17	32	4	12	27
Eastern Europe	5	5	5	5	5	6
USSR	15	17	14	14	14	13
North America	27	26	27	23	24	24
Latin America	15	7	4	25	19	9
Africa and Middle East	20	10	1	13	10	2
Asia	14	17	17	16	17	20
Excluding Japan and Australia	10	5	5	13	8	6
Japan and Australia	4	12	12	3	9	14

Note: Totals may not add due to rounding.

Source: SRI International

Iron and Steel--The figures in Table 27 show that iron and steel production patterns in all regions of the world are almost exactly the same as iron and steel consumption patterns. This is because processing of steel in LDCs is extremely dependent on local markets. One finding of this study is the difficulty iron ore-producing LDCs have in competing in world steel markets because most of these countries would have problems with maintaining competitive quality control, product mix, and delivery commitments. Consequently, LDCs with iron ore must look to themselves to generate markets for their products.

Conclusions--The markets for LDC-processed minerals are an important consideration in the quantity of LDC processing currently taking place. As well as the size of the market, its proximity is also often relevant. One significant reason why LDCs do not forward process more of their minerals is because their internal markets are small, and they have to rely on markets in DCs. Establishment of regional economic unions or regional markets could expand the demand for a particular country's processed minerals, but such increases would be relatively small. This is because of the relative dominance by DCs in the consumption of these metals. Of the three metals studied in this report, steel is the one that could be most impacted by the development of regional markets. If the economies of the LDCs grow more rapidly than is forecast, the demands for their mineral products should also grow more rapidly than shown. The LDC share of world processing thus may increase, as more forward processing could become economically viable. The existence of a greater number of or more effective regional markets would not be expected to significantly affect LDC processing of bauxite/alumina or copper and would affect LDC iron ore processing only moderately.

Social Benefits Versus Private Returns

Private analysis of profitability is based simply on calculations of the difference between earnings and costs. Market prices (usually realized through the interaction of supply and demand) are the fundamental elements used to measure private returns.

Social returns and costs use the same elements used in the calculations of private returns, but go beyond the relatively simple measurement of commercial profitability. Social analysis of profitability seeks to maximize not total dollars or units of other currencies earned, but rather total social gains earned. Social gains are measured in terms of factors relevant to a country's national objectives, such as employment or self-reliance.

The accurate measurement of both private and social returns in minerals processing normally requires careful project by project analysis. In addition, it is often fruitful to conduct social return analyses by sector, analyzing the entire minerals sector of an economy for its social and private returns. To measure social profitability, a country's public policy goals must be well understood; the measuring process can be lengthy and detailed.

Table 27

DISTRIBUTION OF IRON ORE MINING AND STEEL PRODUCTION AND CONSUMPTION BY REGION
(Percentage of World Total)

	1974-1975			1990		
	Iron Ore Mining	Steel Production	Steel Consumption	Iron Ore Mining	Steel Production	Steel Consumption
Western Europe	13	24	23	5	21	22
Eastern Europe	2	8	7	1	9	8
USSR	26	22	19	29	19	15
North America	14	18	24	14	18	18
Latin America	14	3	4	17	6	6
Africa and Middle East	8	1	2	11	3	3
Asia	23	23	21	24	24	27
Excluding Japan and Australia	12	6	7	11	11	14
Japan and Australia	11	17	14	13	13	13

Note: Totals may not add due to rounding.

Source: SRI International

It is not within the scope of this study to conduct either project-based or sector-based private or social profitability analysis. Nevertheless, by examining both LDC and DC policies that influence investment in the minerals sector, by analyzing the economics of processing, and by studying specific countries that both mine and process ore, it is possible to come to some general conclusions regarding the extent of the social benefits realized through mineral extraction and processing efforts. For the three minerals studied and in the several countries examined, SRI found no substantial evidence of social returns from minerals processing being significantly higher than private returns. This does not necessarily indicate that such social benefits do not exist. They in fact may be present either on the project level or in countries other than those examined.

Social benefits realized in the form of employment, income distribution, forward and backward linkages, and foreign exchange are briefly discussed below:

Employment--Mining and processing of the three minerals do not produce substantial employment benefits. The production of alumina and aluminum is very energy intensive and labor unintensive. Capital costs per job in an alumina plant cost over $1 million, whereas that of aluminum would cost at least $250,000 to $330,000 per job.* As Table 9 shows, input requirements for producing 1 ton of refined copper consist of substantial amounts of power and supplies and only 37 hours of labor. Iron and steel production is also a capital-intensive operation.

Income Redistribution--SRI found no evidence of income redistributing effects resulting from LDC minerals extraction and processing. To the contrary, it appeared that substantial amounts of the income earned from minerals processing activities are channeled to expatriates (in the cases of bauxite in Jamaica and iron in Liberia), or used as a working capital (in the case of copper in Zambia).

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*Australia has the largest alumina plant in the world. It produces 2 million tons of alumina per year and employs 1,300 people. A new facility of this size would cost upwards of $650 per annual metric ton, including infrastructure. The capital cost per job created is as follows:

$$\frac{\$650/\text{annual metric ton} \times 2 \times 10^6 \text{ annual metric ton}}{1.3 \times 10^3 \text{ jobs}}$$

$$= \frac{1.3 \times 10^9}{1.3 \times 10^3} \text{ capital cost/job} = \$1{,}000{,}000 \text{ capital cost per job.}$$

Aluminum smelters employ 3 to 4 times as many laborers per dollar invested as aluminum plants, thus $250,000 to $330,000 per job.

Linkages--The minerals sector of the economy of a developing country is generally enclave in nature. It does not provide substantial backward or forward linkages. Backward linkages would be provided, for example, if LDCs produced their own capital machinery to use in mining and processing and if they trained their minerals managers and geologists. Forward linkages would be provided if all the mined ore was not only processed but also made into fabricated end products that would be used in either wholesale or retail products. These types of linkages do not exist with copper in Zambia, iron in Liberia, or bauxite in Jamaica.

Foreign Exchange Earnings--In all the LDCs examined, minerals extraction and processing are substantial foreign exchange earners. The minerals sector in Zambia has provided up to 90% of the country's foreign exchange earnings; the percentages in Jamaica and Liberia are smaller. These foreign exchange earnings, however, do not always provide significant net social benefits. When the price of the exported minerals is low, foreign exchange earnings are relatively low, and often these earnings are used for the purchase of foreign equipment and personnel or for debt service.

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IV THE EFFECTS OF POLICIES ON VARIOUS MINERAL PROCESSING INDUSTRIES IN LESS-DEVELOPED COUNTRIES

Because the most economic processing location varies by mineral, government policies that affect different stages of processing will have different effects on the processing of different minerals. For copper, the most economic processing location is usually near the ore source. For aluminum, the processing of bauxite to alumina is most economic near the bauxite source, but the processing of alumina to aluminum can be done remotely in any location with sufficient energy available inexpensively enough. For iron and steel, the ore can be exported, or the ore can be processed into pig iron that can be exported, but there is very little export market for steel manufactured in LDCs. Production of steel appears likely to develop or expand primarily in countries that have a strong indigenous demand for steel.

Policies that militate against copper production have a stronger effect than policies that encourage it. For aluminum, on the other hand, the policy effect differs by stage; policies that militate against minerals processing will not necessarily discourage the processing of bauxite to alumina while policies that affect the energy supply will have a direct effect on the likelihood of processing alumina to aluminum. Finally, policies have less effect on the development of an iron and steel industry (in contrast to an ore concentration and shipment industry) than does the existence of a market for the iron and steel.

Policies Influencing Copper Processing

Policies against the interests of copper producers have a greater impact on the amount and profitability of copper processing than policies that are in favor of the copper producers' interests. Many governmental policies have the effect of dampening the investment and operating climate. An example of this can be seen in Zambia, where the immediate question is not how much relative processing will take place (because almost all of the mined ore will be both smelted and refined) but the rates of return that will be realized by the copper mining and processing efforts. If the rate of return were to fall below the average minimum level required by the copper producers in the long run, processing efforts would likely come to a standstill. For the Government of Zambia and probably for the governments of the other copper-producing LDCs, an extremely important issue with regard to policies affecting copper is the extent to which the explicit and implied policies reduce the profitability of the integrated copper operations. Processing of copper will most likely take place in the developing countries with the copper ore as long as the net effect of the government policies is to not change importantly the existing economics of the situation.

Policies Influencing the Processing of Bauxite and Alumina

Unlike copper processing, no economic factors make integrated first- and second-stage bauxite processing more attractive than physically separated processing for the two stages. Thus, it is not inevitable that bauxite-producing countries will gain an increased share of the value added in the processing of their ore. An exception to this might exist in the case of ownership agreements, such as the proposed arrangement between Jamaica, Venezuela, and Mexico (see page 74).

Joint equity ventures combine resources from ore producing and non-ore-producing countries to achieve a partnership in the ownership and operation of mining and processing an ore. The necessity for inexpensive (hydroelectric) power for aluminum production makes this type of policy option particularly successful with bauxite/alumina/aluminum, although such arrangements could conceivably be used successfully with other minerals.

Because of the above economics of processing, policies of governments in the bauxite-producing developing countries have a more significant impact in first-stage (alumina) processing than in second-stage (aluminum) processing. Since it is usually economical to perform the first-stage processing at or very near the bauxite mine, when policies are favorable to, or at least do not discourage such production, it is significantly more likely that there will be such processing.

With bauxite, as with the other minerals, where processing capacity is installed and is operating, government policies that inhibit processing may tend to have a greater impact than policies that promote processing, the reasons being simply that the facilities in all likelihood were designed to be operated under a relatively favorable set of conditions. Thus policies which are against the interests of processing can have powerful effects. On the other hand, where no alumina plant exists, or in locations which may have their alumina facilities expanded, policies that are favorable to the alumina operations would have as much impact on decisions regarding processing as policies that are unfavorable. All other things being equal, when policies do not take away from the net revenues or infringe on any of the finances or operations of the minerals/processing companies, alumina processing today is very likely to take place in the bauxite mining country. In this regard, from now through 1985, no nonbauxite-mining developing country is expected to become more involved in alumina production.

A different situation exists for second-stage (aluminum) processing. Any decision regarding where to locate an aluminum plant to a very large extent is based solely on the availability of cheap energy supplies, normally hydroelectric power. Without such power, it is doubtful that aluminum smelting would take place. For this reason, policies of the bauxite-mining developing countries will not affect processing of alumina into aluminum except insofar as they either influence the development or lack of development of potentially available inexpensive energy sources.

Policies Influencing the Processing of Iron Ore

The economics of iron ore processing help to determine the extent of impact that government policies can have. Government guarantees and policies that produce a sound macroeconomic environment can make financing a processing facility easier or less costly. Policies giving special tax or other fiscal incentives can encourage outsiders to come into the LDC to build the facility. Policies can help to provide an adequately skilled labor force to run a steel mill. But policies cannot by themselves develop a market for the steel produced. This is the constraint for LDC-produced steel. Even if the quality of steel produced in a specific iron-ore mining developing country were high, and even if government policies catered to the financial interests of outside investors, the correct sets of market factors do not currently exist. If the world economy strengthened significantly such that demand for steel exceeded existing production capacity, then opportunities might open up for LDC steel exports. Without this and without the development of indigenous markets, the forward processing of iron ore in the iron-ore mining countries does not seem likely in the near future.

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V MINERALS PROCESSING IN SELECTED LESS-DEVELOPED COUNTRIES

Minerals processing has been examined in Zambia, Jamaica, and Liberia, which is to say that processing of copper ore, bauxite, and iron ore have been examined (respectively). In two of the three cases (Zambia and Jamaica), current government policies act to interfere in some way with full production and expansion of forward processing capacity. Further, in each case there are exogenous factors that are at least as important as government policies (closure of a trade route for Zambia, no naturally endowed potential for inexpensive energy in Jamaica, and absence of local markets in Liberia).

Zambia

Processing History and Outlook

The Zambian Government, through its parastatal holding company (the Zambian Industrial and Mining Corporation Limited or ZIMCO), has since 1970 held a 51% share in the two mining and processing companies currently producing copper in the Zambian Copperbelt and at least majority ownership in companies developing reserves in other parts of the country. The two main companies, Nchanga Consolidated Copper Mines Limited and Roan Consolidated Mines Limited, were originally established with private funds as integrated copper producers, with capacity for mining, smelting, and refining.

The Zambian companies currently smelt and refine almost all of the ore they extract (Table 28). In 1975, 97% of the copper ore was smelted and 95% of the smelted copper was refined. Beginning in 1980, Zambian companies are expected to smelt and refine 100% of the copper they extract.

Contribution of Copper Mining and Processing to the Zambian Economy

From independence (1964) until 1975, copper mining, smelting, and processing together accounted for an average of 35% of Zambia's gross domestic product, 45% of all government revenues, and over 90% of export earning (see Table 29).

Copper's contribution to export earnings has fluctuated very little over the past several years, indicative of the heavy reliance of Zambia on copper for its foreign exchange earnings. Moreover, the value of copper exports as a percentage of total exports recently has not moved in the same direction as the price of copper. Copper prices reached their peak in 1974, at which time Zambian copper exports accounted for

Table 28

ZAMBIAN COPPER PRODUCTION
(Thousands of Metric Tons)

	Actual					Projected		
	1955	1960	1965	1970	1975	1980	1985	1990*
Copper ore produced	359	576	696	684	677	605	625	515
Copper smelted	348	576	696	683	659	605	625	515
Copper refined	180	403	522	581	629	605	625	515

*The projected decline in copper production in Zambia is based directly on the plan of the mining companies of Zambia and is a result of declining ore Reserves.

Sources: Metallgesellschaft for actual figures; SRI International for projected figures

Table 29

CONTRIBUTION OF COPPER TO THE ZAMBIAN ECONOMY
(Percent)

	Contribution to Gross Domestic Product	Contribution to Exports	Contribution to Government Revenue
1965	41.0	91.5	65.1
1967	39.8	90.4	61.4
1969	48.7	93.2	58.6
1971	25.2	92.3	36.9
1972	24.4	90.9	17.9
1973	33.7	92.7	27.9
1974	33.4	91.5	51.2
1975*	10.0	93.3	13.3
1976*	11.4	n.a.	2.6

*Provisional.

Sources: International Bank for Reconstruction and Development; SRI International

91.5% of the country's exports. In 1975, even with rapidly decreasing copper prices, copper made up 93.3% of Zambia's exports.

There is a direct relationship between the world market price of copper and the contribution of Zambian copper mining and processing to the country's gross domestic product (GDP) and government revenues. From 1965 to 1974, earnings from copper production accounted for not less than 25% and as much as 48% of GDP. Copper's contribution to government revenues varied even more widely--with a low of 18% and a high of 65%. The dramatic 40% fall in world copper prices in 1975 caused a sharp drop in the contribution of copper to GDP and to government revenues, as can be seen in Table 29.

Mining and processing do not contribute nearly as much to employment in Zambia as they do to GDP and government revenues. Employment in copper mining and processing accounts for less than 5% of total employment, and the share is expected to continue decreasing (see Table 30).

Table 30

LABOR FORCE AND EMPLOYMENT ESTIMATES
(Number of People)

	1969	1974
Mining and processing	55,850	63,630
Other recorded employment	882,500	959,530
Other employment and unemployment	201,275	297,980
Total labor force	1,139,625	1,321,140

Sources: International Bank for Reconstruction and Development, Government of Zambia, Central Statistical Office Monthly Digest of Statistics; and Government of Zambia, Central Statistical Office: Employment and Earning, 1969-1974

Although the monetary contribution from copper has declined recently, copper processing and mining remain dominant in the Zambian economy. Copper is still the principal source from which the country can hope to extract the savings and foreign exchange needed to finance development projects in other sectors.

Zambian Policies Affecting Minerals Processing

Government policies affecting the processing of copper in most countries have the strongest impact in the prefeasibility and feasibility stages. Long-term decisions with respect to the level and extent of mining-processing integration and marketing arrangements are made in the initial project formulation and design stages. These early judgments set the course for several years and, to some extent, have an impact on the degree to which future government policies affect the future processing in the country.

As Zambian copper production included refining from the beginning, governmental actions and policies have not had great impact on the percentage of ore that is processed. Government policies and actions have, however, had a significant impact on the investment and financial situations of the copper companies and on the cost and quantity of copper produced in the country (and hence on the magnitude of processing operations). Although government policies are consequential for the minerals industry in Zambia, their importance is sometimes dwarfed by exogenous factors such as world copper price movements and transport route closure. Government policies directly affecting the availability of funds for copper processing in Zambia include ownership policies, foreign exchange policies, loan guarantee policies and fees, and taxation policies. The costs of Zambian copper are also affected by governmental policies concerning education, expatriate labor, and monetary and material inputs.

Policies Affecting Availability of Capital

The Zambian copper companies in the last few years have had a very difficult time raising funds for capital expenditures. As a result, the capital investment in real terms has been steadily decreasing since 1973, and in 1976 was about 50% of the 1973 level (see Table 31).

Table 31

CAPITAL EXPENDITURES BY ZAMBIAN COPPER COMPANIES, 1972-1976

Year	Millions of Kwachas in Current Prices	Millions of Kwachas in 1969 Prices
1972	84.7	76.3
1973	87.1	76.4
1974	95.7	68.4
1975	96.0	59.6
1976	71.6	39.6

Sources: Annual Reports of Nchanga Consolidated Copper Mines Limited and Roan Consolidated Mines Limited; International Bank for Reconstruction and Development

Ownership

Prior to the 1970 government takeover of a 51% share of the two companies producing copper in the Zambian Copperbelt, funds could be raised at least partly through the issuance of stock. Since the nationalization, there has been no increase in share capital in these companies as the Zambian Government does not desire to subscribe additional capital nor to permit others to do so (and thereby acquire majority ownership). The copper companies are thus restricted to acquiring funds for investment from retained earnings and borrowings.

Retained earnings of the companies since 1974 have been minimal or nonexistent both because of the spectacular 1975 fall in copper prices and because of taxation. To maintain major new investments embarked upon during the period of high copper prices, heavy dependence was placed on obtaining foreign loans. Since 1975, however, the availability of some of these sources of funds has been reduced substantially, at least partly because of exchange shortages in Zambia.

Foreign Exchange Transactions

Copper mining and processing are affected by the specific credit problems of the Republic of Zambia. Heavy reliance on copper exports as the predominant foreign exchange earner puts the country at the mercy of copper prices, and when they fall, export earnings fall dramatically* even though imports in the short run do not adjust fully. The resulting imbalance of payments is reflected in foreign exchange shortages.

The 1975 fall in raw and processed copper prices left Zambia short of foreign exchange, and the central bank of Zambia has had to delay many payment obligations. By law, the copper producers cannot handle foreign exchange transactions themselves and must pass all such transactions through the Bank of Zambia. These foreign exchange shortages have degraded the creditworthiness of the companies as well as of the Government, and as a result the copper producers have had difficulty obtaining external finance.

Guarantee Fees

Since 1975, lenders have become accustomed to receiving government guarantees for major loans to the copper companies. To the lender, an obligation on the part of the Zambian Government has been considered as risk-reducing because the Government at least potentially has emergency

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*A one cent decrease in the price of copper represents a loss of approximately U.S.$1.5 million to Zambia's gross foreign exchange earnings.

resources of which to avail itself (specifically, its foreign exchange reserves and the various credit facilities of the International Monetary Fund). Loan guarantees used to be made without any direct cost to the companies. In January of 1977, the Finance Minister announced that the borrower would have to pay the Government 1.25% of the principal amount for any subsequent guarantees. This surcharge has further reduced the availability of financing to the copper producers by raising the cost of such financing.

Taxation

The Zambian Government's taxation (and dividend) policies also affect investment. Taxation in 1978 of the copper sector consists of a mineral tax equal to 51% of estimated profits and a profit tax of 50% on the profit net of the mineral tax. The effective tax rates on the companies are thus 74.5%. This heavy tax burden substantially limits the companies' ability to retain earnings. Tax laws have changed since 1970, and Table 32 depicts the tax burden the companies have faced. In the period 1970-75, the tax burden on the copper producers has not been less than 46% and has been as high as 73%.

Table 32

ZAMBIAN GOVERNMENT REVENUES
AND COMPANY-RETAINED EARNINGS FROM COPPER PROFITS
1970-1975
(Millions of Kwachas)

	1970	1971	1972	1973	1974	1975
Profits (losses) before depreciation	289.9	154.1	178.9	499.0	179.0	(633)
of which = Taxes	121.7	42.8	51.2	308.0	87.9	-
= Dividends	62.8	56.5	67.0	113.3	23.5	-
Government revenue						
Taxes + (0.51 × dividends)	153.8	71.6	85.3	364.8	99.9	-
(as percentage of gross profits)	53.1%	46.5%	47.7%	73.1%	55.8%	-
Retained earnings before depreciation	105.4	54.8	60.7	79.7	67.6	-

Sources: Annual Reports of Nchanga Consolidated Copper Mines Limited, Roan Consolidated Mines Limited; and International Bank for Reconstruction and Development

Policies Affecting Production Costs

Government policies and actions have also had a significant impact on production levels and costs of the copper companies. These policies are basically of two types: those resulting in a lack of skilled personnel, and those impeding the flow of needed financial and material inputs.

Skilled Personnel--Too few Zambian graduates are available to fill skilled labor and management positions in the processing activities. University training has produced relatively few mining graduates compared to current needs and previous expectation. A 1974 Government forecast projected that by 1977, as many as 70 Zambian graduates (in metallurgy, mining engineering, and geology) per year (from the University of Zambia as well as overseas institutions) might be ready to enter mining operations. However, because of a lack of qualified candidates and the diversion of candidates into other fields, no more than 14 graduates were expected in 1978 (Table 33).

Table 33

FORECAST NUMBER OF GRADUATES IN MINING AND RELATED FIELDS FROM UNIVERSITY OF ZAMBIA 1978-1983*

Types of Graduates	1978	1979	1980	1981	1982	1983
Metallurgists	6	13	8	10	6	10
Mining engineers	6	13	8	10	6	10
Geologists	1	6	5	4	5	4
Total	13	32	21	24	17	24

*Does not include Zambians expected to receive degrees abroad (about 5%).

Because there are too few Zambians who can fill managerial and skilled labor positions in the copper companies, there is a heavy dependence on expatriates to run the country's copper production efforts. In recent years, the expatriate labor force has been shrinking in size, and turnover has been increasing.

Zambia restricts repatriation of earnings. Expatriates can now send only one-third of their salaries out of the country, and in times of emergency even this may be halted. Second, many senior expatriates are

said to believe that the ideologies of the Government, including its push to Zambianization, are a threat. Third, the standard of living is declining. Expatriates complain, for example, that the Government should ensure the availability of basic foods and not allow shortages of milk, butter, and eggs to continue.

Problems with the turnover and experience level of expatriates in copper production are partly responsible for the declining labor productivity in the Zambian Copperbelt. Although lack of data makes it impossible to separate mining productivity from processing productivity, the steady decrease in the productivity of the composite copper company employees can be seen from Table 34. Other factors related to Government policies said to be responsible for the declining productivity include the rapid growth of the relative share of overhead personnel (a result of Government efforts to put more Zambians in managerial positions) and the increasing downtime (a result of insufficient spare parts and extended machinery breakdowns).

Table 34

COPPERBELT LABOR PRODUCTIVITY, 1969-1975

Year	Labor Force	Metric Tons Ore Hoisted per Person-Shift*	Kilograms Contained Copper per Person-Shift	Person-Shifts Required to Produce One Ton of Contained Copper†
1969	48,227	2.25	52.19	19.18
1971	49,748	2.05	42.63	23.46
1973	52,792	2.21	43.11	23.20
1975	57,487	1.99	37.56	26.62

*Person-shifts estimated at 300 per year per employee.

†This may to some degree reflect declining quality of the copper ore, but in large part is based on declining labor productivity.

Source: Zambia Mining Yearbook (Copper Industry Services Bureau, P.O. Box 2100, Kitwe, Zambia)

Another way of looking at labor problems is through the measure of labor cost per unit of value added. Table 35 shows that between 1965 and 1974, the ratio of wages per worker to value added per worker in the mining sector has more than doubled. This compares unfavorably to trends in the services and manufacturing sectors, but is roughly equivalent to trends in the construction and transport and communications sectors.

Table 35

INDEX OF LABOR PRODUCTIVITY AND LABOR COST, 1965-1974
(1965 = 100)

	1965	1967	1969	1971	1973	1974
Mining						
Value added per worker	100	75	83	63	66	65
Wages per worker	100	140	141	142	160	161
Labor cost per unit of value added	100	186	172	227	242	247
Manufacturing						
Labor cost per unit of value added	100	101	103	137	114	99
Construction						
Labor cost per unit of value added	100	214	222	219	193	210
Transports, Communications						
Labor cost per unit of value added	100	148	210	200	190	202
Services						
Labor cost per unit of value added	100	113	145	119	152	134

Sources: Government of Zambia Central Statistical Office, Monthly Digest of Statistics; International Bank for Reconstruction and Development

Financial and Material Inputs--Many domestic suppliers of copper processing spare parts and equipment, who until recently have provided reliable services at competitive prices, have been unable to function because of an inability to obtain either foreign exchange allocations or import licenses, or both. Although the copper companies are increasingly taking over importation of their own supplies and are ostensibly accorded priority in obtaining necessary foreign exchange, delays continue.

As a result, companies have attempted to maintain greater levels of (increasingly expensive) spare parts and other stores. The real value of stores held by the mining companies has been increasing since 1970 at an average annual rate of 14% (Table 36), and the stock of spares and replacements for many items has increased from an anticipated 6 months' supply to a 2-year supply. Such increases may consist of shifts in the location of stores from one part of the Zambian economy to another. Nevertheless, there has been a real increment to production costs of the copper companies represented by the additional expenses which accompany the maintenance of stores. Assuming the conservative estimate that these costs represent approximately 10% of the value of the stores, the cost of stores per ton of finished copper accounts for an approximate 0.4% annual increase in the real unit cost of producing finished copper.

Table 36

VALUE OF MINING COMPANIES' STORES, 1970-1975

Year	Average Value of Stores, Millions of Current Kwachas	Average Value of Stores, Millions of Constant (1970) Kwachas
1970	50.1	50.1
1971	54.6	52.3
1972	57.8	51.5
1973	87.1	73.5
1974	129.5	113.6
1975	149.8	98.6

Sources: Annual Reports of Nchanga Consolidated Copper Mines Limited; Roan Consolidated Mines Limited; International Bank for Reconstruction and Development

Summary and Conclusions

Barring any major and unexpected problems with processing equipment, the Zambian companies will both smelt and refine all the copper produced in the country. Zambia has operating capacity sufficient to process all of the copper mined.

The policies and actions of the Zambian Government are important to the profitability and thus to the future of copper processing in Zambia. The combination of recent government policies and external factors has resulted in several problems for the country's copper industry. Copper mining and processing have been adversely affected by two exogenous factors (transport route closings* and reduced copper prices), as well as by some of the actions that the government is pursuing. In particular, the difficulties the companies have had acquiring funds have decreased potential levels of capital investment which will in turn restrict future processing capacity. Further, while one of the Government's efforts has been to put more educated Zambians in responsible positions in copper processing and mining, insufficient numbers of qualified Zambians have been attending Zambian and foreign universities to compensate for the loss of expatriates, which has affected copper production.

*As a result of political differences between Zambia and Rhodesia, the export products of landlocked Zambia could no longer be sent by the most economical route through Rhodesia.

If world copper prices climb again so that they regain the peak 1974 level, Zambian Government policies probably will change substantially. Problems with the availability of foreign exchange or spare parts should decrease, capital expenditures by the companies should increase; and the Government would probably allocate more funds to education in the earth sciences and engineering fields, producing needed professionals.

Overall, in the short run Zambian Government policies gain importance to the copper processing sector as the price of copper decreases. When copper prices are low, relatively small changes in the Government policies can turn a marginally profitable operation into an unprofitable one. Conversely, Zambia's policies lose importance as the price of copper increases. Over the long run, however, highly volatile copper price will, on balance, minimize the temporary effects of such temporary policies.

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Jamaica

Processing History and Outlook

Jamaican forward processing of bauxite is limited to the production of alumina. The country has no aluminum smelting facilities and currently has no definite plans for installing such capacity. Alumina refining is limited to less than 20% of the available supply of bauxite, and forecasts show this share is expected to increase only modestly over the next several years (see Table 37).

Table 37

PROCESSING HISTORY AND OUTLOOK FOR JAMAICAN BAUXITE
(Thousands of Metric Tons)

	1960	1965-1966	1970	1975	Ten-Year Outlook
Bauxite production	5,837	8,651	12,010	11,571	No significant growth
Alumina production		804	1,797	2,242	Slight growth
Aluminum production			None		

Sources: Metallgesellschaft for 1960 through 1975; SRI International for 10-year outlook

The country does not have the facilities to produce substantially more alumina than at present. Like the bauxite operations, the processing facilities are owned by a partnership of the Jamaican Government and private foreign interests, with the government retaining majority control of the operations. The Government of Jamaica does not have the financial resources needed to expand alumina facilities, and the private companies are not currently interested in increasing their Jamaican operations.

The Government is very interested in gaining an equity interest in additional alumina and aluminum processing facilities. The installation of an aluminum plant in Jamaica will not be practicable until a sufficiently inexpensive source of energy is developed or a method of producing aluminum is devised that uses only a fraction of the energy needed by current methods. At present, the most Jamaica could accommodate would be additional alumina facilities.

Foreign private interests have indicated that they would not participate in any new processing ventures in Jamaica as long as current conditions persist. Further, official aid is unlikely to be adequate to finance new processing plants. In the absence of private foreign investment or

official aid, there are still options available to the Jamaicans. One option being considered is a joint venture among Jamaica, Venezuela, and Mexico, nicknamed "JAVEMEX." The suggested arrangement would call for equity investment for bauxite mining in Jamaica, alumina refining in Jamaica, and aluminum smelting in Mexico, as shown in Table 38.

Table 38

POSSIBLE "JAVEMEX" ARRANGEMENT
(In Percent)

	Bauxite Mining (in Jamaica)	Alumina Refining (in Jamaica)	Aluminum Smelting (in Mexico)
Jamaica	71	51	29
Mexico	29	29	51
Venezuela	--	10	--
Technical partner	--	10	20

Source: International Bank for Reconstruction and Development

This arrangement would give the Jamaicans majority ownership of both the bauxite and alumina facilities, and a 29% interest in the Mexican aluminum plant. Jamaica would process more of its bauxite, would have a guaranteed market for its alumina, and would reap returns from the final-stage (aluminum) processing. Difficulties could arise in working out the specifics of JAVEMEX, but within the next several years there is a moderate probability of successful implementation of the arrangement.

Investment cost for the new plant and equipment would come in part from borrowed funds and in part from revenues of the four owners of the projects. It is estimated that the total cost (1976 U.S. dollars) would be at least $350 million for the alumina refinery and $275 million for the aluminum smelter.

Contribution of Bauxite and Alumina to the Jamaican Economy

The contribution of bauxite and alumina to the Jamaican economy is substantial (Table 39). Since 1970, mining and smelting together have accounted for between approximately 14% and 16% of Jamaican gross domestic product (GDP). Sales of alumina have accounted for between 22% and 40% of total export earnings, and bauxite and alumina together made up from 38% to 55% of export earnings (Table 40).

Table 39

SECTORAL ORIGIN OF GROSS DOMESTIC PRODUCT
(ADJUSTED) IN CURRENT PRICES AT FACTOR COST
1970-1974
(Jamaican Dollars)

	1970	1971	1972	1973	1974
Mining, quarrying, and refining	159.6	173.4	169.8	178.8	205.0
Bauxite and alumina	149.7	161.2	158.4	168.5	194.7
Other	9.9	12.2	11.4	10.3	10.3
Total GDP at factor cost	1003.4	1064.6	1166.7	1185.3	1249.1

Sources: Jamaican Department of Statistics; Bank of Jamaica

Table 40

PERCENTAGE COMPOSITION OF JAMAICAN EXPORTS IN CURRENT PRICES
1970-1974

	1970	1971	1972	1973	1974
Bauxite	17.6%	16.7%	14.1%	13.8%	15.4%
Alumina	25.6	22.9	24.7	25.7	39.6
Total merchandise Exports	65.6	63.2	62.1	62.2	72.2
Non factor services	34.4	36.8	37.9	37.8	27.8
Total exports of goods and services	100.0	100.0	100.0	100.0	100.0

Sources: Jamaican Ministry of Finance; International Bank for Reconstruction and Development

The net contribution of the bauxite-alumina sector to foreign exchange earnings and taxes is shown in Table 41. Bauxite-alumina tax revenues as a percentage of GNP ranged from 2.5% to 8.3%. The net foreign exchange contribution* of the sector varies between 9.5% and 13.9% of Jamaica's GNP. The bauxite-alumina industry, employing between 6,800 and 7,600 persons, does not provide a substantial share of the country's jobs. Further, the capital costs per unit of employment were rather high, at $75,000 to $107,000.

Table 41

BAUXITE-ALUMINA: SELECTED ECONOMIC INDICATORS

	1972		1973		1974	
	Millions of Jamaican Dollars	% GNP	Millions of Jamaican Dollars	% GNP	Millions of Jamaican Dollars	% GNP
Net contribution to foreign exchange	171.3	12.6	155.4	9.5	299.4	13.9
Of which: tax revenue	35.6	2.6	41.0	2.5	179.1	8.3
Percentage of total thousands employed						
Employment contribution	6.8	1.1	7.0	1.1	7.6	1.2
Capital costs per unit employment			75,000 - 107,000			

Source: International Bank for Reconstruction and Development

According to the 1975 World Bank calculations, value added in bauxite mining in Jamaica has been substantially higher than value added in alumina production. The ratio of value added in bauxite to value added in alumina has ranged from 2.88 to 15.73 and averages 6.80 over the 1970-1974 period. Each year's value of production of bauxite was very close to the value of production of alumina during the period 1970 to 1974. The difference in

*Net Foreign Exchange Contribution is defined as the amount of foreign exchange earned from the sales of bauxite and alumina less the amount of foreign exchange spent on materials and labor in the production processes.

value added comes from the inputs into the production process--the value of material inputs to bauxite production are almost negligible, whereas those into alumina production are substantial--and from the substantial economic rent associated with the bauxite resource. Although there was positive value added in the production of both commodities, the production of bauxite contributed almost seven times as much value added to the Jamaican economy as did the production of alumina (Table 42).

Effect of Jamaican Policies

The Government's policies affect the minerals processing sector a great deal, but rarely does the effect show up immediately in output tonnage. Mineral extraction and processing activities ordinarily change their production capacities only slowly, as several years are required before new capacity can be brought on-stream. In this type of situation, responses to policy actions are quicker when restrictive policies are involved than when producing-enhancing ones are involved. Since many of the most recent policies in Jamaica have cut the profitability of the privately held bauxite and alumina companies, the Government is perceived as having an attitude that makes new investment unattractive, and this "attitude" has had noticeable effects on the country's bauxite processing efforts. However, it is not Jamaican Government policies that prevent the installation of aluminum production, but lack of inexpensive energy for the present energy-intensive process.

Since the Government has adopted policies that made the country's investment climate increasingly unattractive, there has been a noticeable effect on the bauxite processing industry in Jamaica (Table 43).

Foreign exchange rate policies have probably had the single most harmful impact on Jamaica's processing. The Government maintains a dual exchange rate system:

U.S.$ 1.00 = J$ 1.35
U.S.$ 1.00 = J$ 1.05.

The J$ 1.35 exchange rate is applicable to most trade except that in bauxite and alumina, but the J$ 1.05 rate is the one that bauxite/alumina companies must use in their transactions. This rate, which has the effect of an export tax, severely handicaps the companies by making them less competitive. The free market rate of exchange is estimated to be: U.S.$ 1.00 = J$ 1.65.

The bauxite/alumina producers apparently are in the process of trying to negotiate a shift to the J$ 1.35 rate and in exchange are offering to pay the Government a full one-year advance on the bauxite levy. It is not known at this time what position the Jamaican Government will take.

Other policies affecting the mineral companies are more general in nature and have to do with overall macroeconomic management difficulties. In the last few years, wage increases in Jamaica have been greatly in excess of productivity gains (Table 44).

Table 42

VALUE ADDED IN BAUXITE AND ALUMINA PRODUCTION IN JAMAICA
1970-1974
(In Millions of Current Jamaican Dollars)

	1970	1971	1972	1973	1974
Value added*					
Bauxite					
Gross value of production†	118.6	120.0	119.7	146.4	257.9
Less: materials and services--domestic	7.1	3.1	5.9	10.8	10.2
Less: materials and services--foreign	0.8	1.5	1.2	1.9	5.3
Equals: value added at market prices	110.7	115.4	112.6	133.7	242.4
Alumina					
Gross value of production†	109.2	109.7	109.6	124.2	281.3
Less: value of bauxite converted‡	42.1	45.1	46.6	54.5	95.8
Less: materials and services--domestic	12.8	5.1	12.4	20.0	18.9
Less: materials and services--foreign	15.8	28.4	34.5	41.0	115.4
Equals: value added at market prices	38.5	31.1	16.1	8.5	51.2
Total: calculated total value added at market price	149.2	146.5	128.7	142.2	293.6
Less: indirect taxes and royalties	-3.7	-4.3	-5.3	-6.6	-12.9
Equals: calculated total value added at factor cost	145.5	142.2	123.4	135.6	280.7
Ratio of value added in Bauxite to value added in Alumina	2.88	3.71	6.99	15.73	4.73

*Conversion ratio used is 2.50 tons bauxite = one ton alumina.

†Production volume times unit value of exports.

‡Volume times unit value of exports.

Source: International Bank for Reconstruction and Development

Table 43

BAUXITE AND ALUMINA PRODUCTION IN JAMAICA
(Millions of Metric Tons)

Production	1971	1972	1973	1974	1975	1976
Bauxite	12.5	13.0	13.6	15.3	11.6	10.3
Alumina	1.9	2.1	2.5	2.7	2.2	1.6

Source: Metallgesellschaft

Table 44

INDICES OF KEY PRICES AND LABOR PRODUCTIVITY IN JAMAICA
(1971 = 100)

				Average Annual Change (percent)	
	1971	1973	1975	1971-1975	1973-1975
Industrial wage index	100	141.6	302.8	31.5	46.1
GDP deflator (factor cost)	100	117.5	170.7	14.3	20.5
Real wage index	100	100.6	150.7	10.8	22.4
Labor productivity index for industry*	100	109.6	112.8	2.7	1.0

*Corresponding to GDP and employment in six sectors: manufacturing, transport and communication, construction, mining (quarrying and refining), commerce, and other.

Sources: International Bank for Reconstruction and Development; Jamaican National Planning Agency

Whereas average labor productivity from 1973 to 1975 increased only 1% per year, average real wages in the same period increased 22% per year. A similar though less severe situation existed throughout the 1971-1975 period, with real wages increasing 10% and productivity increasing only 3%.

Government fiscal policies in 1974-75 resulted in a large increase in the central Government budget and spending, which was said to be the result of short-sighted and false expectations regarding the newly instituted bauxite levy and of an unsuitable budgetary procedure. The proceeds from the bauxite levy were not transferred to the general fund of the country, as many Government officials had originally thought they would be. Instead, such funds were put into the extra-budgetary Capital Development Fund to be used solely to create new foreign exchange earning industries in Jamaica.* How public sector expenditures in Jamaica increased is shown by the following (millions of Jamaican dollars):

Year	Amount†
1970/71	J$ 317.9
1971/72	360.8
1972/73	430.5
1973/74	559.5
1974/75	858.1 (estimated)

The country had been running balance of payments deficits for several years (Table 45), which had been funded through various sorts of debt arrangements. The continuance of this problem in an otherwise difficult period resulted in further difficulties with the balance of payments and added a further dimension to the tensions between the bauxite-alumina producers and the Government.

All of these factors contributed to a deteriorating domestic economy, and when combined with the new bauxite levy and the dual exchange rate system, produced an unfavorable (and even antagonistic) investment climate.

Currently, Jamaica is still facing serious balance of payment problems. As of the middle of April 1978, the country was not even able to meet the objectives of a preliminary stabilization agreement jointly conceived and agreed to by officials of the Jamaican Government and the International Monetary Fund. The Jamaicans needed the support of the IMF

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*In fact, because of the immense over-expenditure problems, the Capital Development Fund later did lend some of its monies to the General Consolidated Fund.

†International Bank for Reconstruction and Development.

Table 45

JAMAICAN BALANCE OF PAYMENTS
(Millions of Jamaican Dollars at Current Prices)

	Receipts	Expenditures
1971	286.1	395.1
1972	303.0	422.9
1973	357.2	518.4
1974	632.2	739.4

Source: Jamaican National Planning Agency, Economic and Social Survey, 1974

and the temporary loans from the Fund to prevent defaulting on their obligations or creating a serious disturbance in their economy. It seemed likely (May 1978) that an appropriate agreement would soon be reached.

As a result of the combination of problems, foreign companies cut their mining levels from 15 million to 10 million tons and cut alumina production from 2.7 million to 1.6 million metric tons (Table 43). Because it is expected that with IMF assistance the Jamaicans will very soon improve the performance of their economy and thus their investment climate, the bauxite-alumina companies are preparing to build back up to their 1974 production levels.

Nevertheless, considerable apprehension remains in relations between the companies and the Government. It appears that if there are any further actions or policy changes by the Jamaican Government which have very harmful effects on the operations of the companies, the companies may seriously consider leaving Jamaica.

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Liberia

Processing History and Outlook

Iron ore mining in Liberia has grown at a spectacular rate rising from 3 million tons in the early 1960s to 23 million tons in the early 1970s. In the 1975 to 1976 period, shipments declined in response to the downturn in the world economy. Prospects for future increased production and exports of iron ore appear to be encouraging, particularly in view of the recovery of the economies of the industrialized countries and the projected demand for iron and steel products. By 1983, Liberia's exports of iron ore are expected to reach close to 32 million tons per year (Table 46).

Table 46

LIBERIAN IRON ORE PROCESSING HISTORY AND OUTLOOK
(Millions of Long Tons)

	Actual			Projected				
	1970	1973	1975	1981	1983	1985	1987	1990
Total iron ore production	23.4	23.[illegible]	21.6	24.0	31.8	43.8	53.3	53.3

Sources: Metallgesellschaft for actual figures; SRI International for projected figures

Liberia currently does not forward process its ore into steel and has no plans to do so. Foreign companies have full ownership of the mining operations in Liberia, and they control both production and marketing in response to factors outside of Liberian control. The companies mine and produce the ore with the stated purpose of using it as input into steel-making operations in their home countries. It would not be in the interests of the foreign companies to build steel facilities in Liberia when sufficient steel production capacity already exists in Europe and the United States, unless it would be more profitable to produce steel in Liberia. This, however, is not the situation.

With a population of only 1.5 million persons, Liberia uses an insignificant amount of steel in the form of end products such as cars and machinery. In addition, West Africa offers little local market for steel. Without the ability to export much steel either to the developed countries or to neighboring African countries, even if Liberia manufactured iron and steel, it would be very difficult to market the products.

If the Government of Liberia wanted to sponsor a steel-making project on its own, the cost would be very high. Assuming the financing would be available, the Liberians would need to go heavily in debt, taking resources from other development projects that might well have higher returns. Further, the country would have to import at least some technical know-how, possibly in the form of skilled laborers and/or managers. The outlook for forward processing of iron ore in Liberia thus appears bleak, at least in the near future.

Contribution of Iron Ore to the Liberian Economy

Iron ore mining is the single most important nonagricultural activity in the Liberian economy. Such mining is estimated to have contributed 23% of GDP in 1976 (Table 47). Exports of iron ore are estimated at $343 million in 1976 and will account for about two-thirds of the value of total merchandise exports for the year. The contribution of iron ore receipts to government revenue is estimated at $29.3 million, equivalent to about 20% of total government current revenues. The contribution of iron ore mining to Liberian employment is relatively unimportant in contrast to its influence in other respects; mining is estimated to account for up to 10% of total employment. Despite the quantitative importance of iron ore in the Liberian economy, the significance of this sector to the development of the economy has been relatively small because of the enclave character of the activity and the limited linkages with the rest of Liberia's economy.

Table 47

CONTRIBUTION OF IRON ORE TO THE LIBERIAN ECONOMY
(Percent)

	GDP	Exports	Government Revenues
1968	28	n.a.	21
1970	27	64	23
1972	28	68	21
1975	25	74	16
1976	23	n.a.	18

Sources: International Bank for Reconstruction and Development; SRI International

Approximately 37% of the total sales income from iron ore sales consisted of payments for local goods and services or payments to the Liberian Government. It has been estimated, however, that $50 million of this $108 million represents payments for oil products, cement, and other items which are imported from overseas by the iron ore companies. In terms of Liberian payroll and salaries, the money retained in the country is estimated at $36 million, or 12¢ for every dollar of sale income generated by the iron ore industry (Tables 48 and 49).

Table 48

TOTAL LIBERIAN RECEIPTS FROM THE IRON ORE COMPANIES
1975
(Millions of U.S. Dollars)

	Liberian American-Swedish Minerals Company	Bong Mining Company	Liberian Mining Company	National Iron Ore Company	Totals*
Liberian payroll and salaries	24.0	4.7	3.2	3.6	35.5
Consular invoices	0.3	0.4	-	0.1	-
Other taxes	1.0	0.2	-	0.3	-
Payments to local contractors	4.0	1.5	2.1	0.4	52.6
Local purchases	14.0	22.5	-	2.6	-
Others (contributions, schools, etc.)	3.0	0.1	-	0.1	-
Withholding taxes	1.4	-	-	-	1.4
Subtotal	47.7	29.4	5.3	7.1	89.5
Government of Liberia share*	12.3	3.0	2.9	-	18.2
Total	60.0	32.4	8.2	7.1	107.7
Sales income, %	41%	32%	37%	37%	37%

*The government of Liberia requires that mining concessions return a percentage of profits to the country ("profit-sharing").

Source: International Bank for Reconstruction and Development

Table 49

AGGREGATE COSTS AND REVENUES OF THE FIVE IRON ORE COMPANIES
1967-1980

	1967-1975	1976-1980
Costs and revenues (millions of U.S. dollars)		
Sales income	1,648.6	2,116.8
Operating, administration, and selling costs	883.0	1,415.8
Amortization and depreciation	270.0	284.9
Depletion allowance	14.8	29.2
Other costs (income)	(0.1)	10.8
Total costs	1,166.6	1,740.6
Earnings before interest and Government's share	482.0	376.1
Interest	178.9	129.8
Net profit before Government's share	303.1	246.3
Government's share	117.6	117.4
Government's share as a percentage of sales income	7.1	5.5
Government's share as a percentage of earnings before interest	24.4	31.2
Government's share as a percentage of net profit	38.8	47.7
Government's share per ton shipped (millions of U.S. dollars)	0.6	1.04

Source: International Bank for Reconstruction and Development

Effect of Liberian Policies

Liberia actively encourages foreign private investment in most forms. Policies in this country are such that expatriates and foreign nations are invited to come into the country to, among other things, extract and process minerals. The government puts it this way:*

> Liberia is a free enterprise economy butteressed by the Open Door Policy which was declared over three decades ago. Within this framework, the Government of Liberia continues to provide the necessary incentives and supportive infrastructural facilities to create a suitable investment climate and promote private initiative not only for Liberian citizens but

*Advertisement in Wall Street Journal, April 10, 1978.

also for foreign investors who have the required capital and technological and managerial know-how and are willing to become partners in our efforts to build a vibrant economy and society based on principles of justice and equity.

The Government has a liberal investment incentive program supported by an Investment Incentive Code. Some of the incentives granted under the code include:

1. Ninety percent import duty exemption on machinery equipment and raw materials up to a maximum period of 7 years.
2. Income tax exemption for a maximum period of 7 years; and
3. Provision for accelerated depreciation.

Investors are also assured of Government's policy of non-nationalization of private enterprise as well as the guarantee of complete freedom of international payments and exchange transactions.

The mining companies are exempt from general taxation laws under their concession agreements with the Government of Liberia. In principle, the Government is to receive 50% of the net distributed profits after appropriations to reserves and interest payments. In practice, the companies decide what portion of their profits to distribute, and this results in the Government receiving substantially less than one-half of the net profits. Further, total profits are reduced substantially by high debt ratios. The concession agreements with the companies allow debt-equity ratios of up to 3.5 to 1. The companies have taken advantage of this provision to maximize their debt, particularly with loans from stockholders. Interest payments on these loans have been high and have adversely affected the Government's share of iron ore profits.

Even though Liberia has a set of policies that are very attractive to outside investors and wants foreign investors to enter the country, there is little possibility in the foreseeable future that Liberia will forward process its iron ore.

VI DEVELOPED COUNTRY POLICIES

Introduction

Policies implemented by developed countries that affect forward processing of minerals in LDCs can be divided into two basic types: (1) trade barriers and (2) incentives for private companies to invest in LDCs. This chapter discusses relevant U.S. policies and then briefly summarizes similar policies of other DCs. Emphasis is placed on how these policies impact the LDCs, and only peripheral attention is given to impacts on the DCs themselves.*

Trade barriers include nominal and effective tariff rates and nontariff barriers, such as licensing agreements, quotas, voluntary restraints, and various miscellaneous regulations. As discussed below, trade barriers provide a negative influence on forward processing of minerals in LDCs as the effective rate of return for such investment is reduced.

Direct foreign investment in LDCs by multinational mining corporations historically has been the impetus for forward processing activity. Recently, the LDC governments have taken over much of the building and operation of processing facilities, but have found capital requirements and technical skills are sufficiently high that often larger scale plants require some assistance from multinational mining corporations and/or lending institutions. To encourage U.S. private concerns to invest in LDCs and U.S. banks to make loans for investment projects in LDCs, the U.S. Government has established the Overseas Private Investment Corporation to insure against noncommerical losses.

Trade Barriers

Nominal Tariffs

As with most developed and developing countries, the U.S. tariff system is designed, in part, to protect domestic industries. Because domestic supplies of copper, bauxite, and iron ore are insufficient to cover domestic demand, U.S. tariffs on these crude ores are low to nonexistent.

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*Numerous studies have been conducted on the impact of reduced trade barriers on domestic industries. For example, see Robert E. Baldwin, Trade and Employment Effects in the United States of Multilateral Tariff Restrictions, mimeographed (1976); or Federal Trade Commission Staff Report on The United States Steel Industry and Its International Rivals (November 1977).

For many of the processed ores and products, tariff rates become significant. Table 50 shows the levels of tariffs for crude and refined minerals covered in this study. Whereas most imports of unprocessed bauxite, copper, and iron ores are not subject to tariff charges, tariffs on refined and/or processed products are equal to about 8% to 10% of their value.* This type of tariff structure has a negative influence on forward processing of minerals in LDCs. Because the markets for processed minerals are generally small in the LDCs, these countries must look to the industrialized countries to provide export markets. High tariffs on processed minerals can make forward processing in LDCs less profitable than in the DCs. Furthermore, processed minerals from LDCs may be imperfect substitutes for those from industrialized countries in world markets because of differences in quality, delivery time, credit, and so forth.† Consequently, when considering these factors along with the risks involved in investing in LDCs, the large, multinational corporations are less willing to invest in these countries. Also, government-owned facilities in LDCs probably are less profitable than they would be in absence of DC tariff duties.

It is not clear that general tariff reductions will provide significant help to forward processing of minerals in the LDCs. Baldwin estimated the impact of a multilateral, 50% linear cut in tariffs on U.S. employment under the assumption that exchange rates remain fixed.‡ Baldwin categorized industries as being import-sensitive or export-sensitive based on employment losses or gains, respectively, in each of the industries examined. It should be noted these impacts arise from tariff cuts in all industries and reflect direct and indirect effects. Iron, ferroalloy, and other nonferrous mining would suffer a loss of employment in excess of 0.5% of their labor forces, as would primary aluminum, primary nonferrous metal, and fabricated metal products. Thus, generally lower tariffs would tend to increase imports of mineral products and to displace domestic labor. However, as shown in Table 51, the LDCs would not necessarily receive a large share of these increased exports. For iron and steel products (which amount to about 77% of the value of processed product imports of the three minerals examined), the LDCs accounted for only 7% of total imports in 1975. In 1976, about 20% of aluminum product and about 50% of copper product imports came from the LDCs. These shares are

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*Duties on iron and steel products average about 7% to 8% of their value, whereas those on copper products average about 10% to 12% depending on the price of copper. Duties on aluminum products vary significantly from about 2% or 3% for unwrought aluminum to 12% for certain types of bars, plates, sheets, and strip.

†Robert Baldwin and Tracy Murray, "MFN Tariff Reductions and Developing Country Trade Benefits Under the GSP," The Economic Journal (March 1977).

‡Robert Baldwin, Trade and Employment Effects in the United States of Multilateral Tariff Restrictions, mimeographed (1976).

Table 50

ESTIMATED TARIFF RATES FOR ALUMINUM, COPPER, AND IRON AND STEEL

	Cents per Pound		Ad Valorem (percent)	Arithmetic Average (percent)	Trade-Weighted Average (percent)
Iron ores			Free		
Iron and steel*					
All products				7.2	6.6
Dutiable products				7.4	6.7
Nonferrous metals*					
All products				7.7	2.7
Dutiable products				8.1	3.8
Bauxite			Free		
Alumina			Free		
Aluminum†	1.3	or	9.3		
Copper ores			Free§		
Copper products‡					
Under 24¢/lb	1.0	and	6.6		
24¢/lb and over	0.9	and	6.6		

*From U.S. Tariff Commission, Trade Barriers, Part 3, Major Industrial Product Sectors: Tariffs and Other Trade Barriers, April 1974.

†Tariffs and arithmetic average of rates for paroduct with TSUS numbers 618.01 to 618.48. As all but one product has either a per pound or an ad valorem tariff, the average cents per pound (respectively, ad valorem) rates quoted reflect just those products whose tariff is computed as cents per pound (respectively, ad valorem) basis.

‡Tariffs are arithmetic averages of rates for products with TSUS numbers 612.02 to 613.19. Tariffs for most products are on a per pound and ad valorem in bases, so rates quoted reflect the average for all 612.02 to 613.19 products.

§Some tariff (approximately 0.8¢/lb) is assessed on copper content in products with TSUS numbers 602.28, 602.30, 603.50, 603.54, and 603.55. All of these categories are included under GSP.

Source: SRI International

Table 51

DISTRIBUTION OF IRON AND STEEL IMPORTS
1975

	Weight (thousands of tons)	Percent Distribution
Steel products		
Canada	1,071	8
Australia and Oceania	55	0
Japan	6,214	49
Europe	4,702	37
Latin America	113	1
Asia and Africa (excluding Japan)	515	4
Total	12,669	100
Iron products and ferroalloys		
Canada	287	23
Australia and Oceania	18	1
Japan	244	20
Europe	337	27
Latin America	71	6
Asia and Africa (excluding Japan)	293	23
Total	1,250	100

Source: American Iron and Steel Institute, Annual Statistical Report, 1975

subject to change, and in the future the LDCs are generally expected to be producing a greater proportion of the world's processed minerals. Although the bulk of U.S. imports of bauxite originate in LDCs, most imports of crude iron and copper ores come from DCs and especially from Canada. Thus, the potential for large-scale shifts in the composition of U.S. imports from the LDCs away from crude ores and toward refined products appears to be somewhat limited, with aluminum showing the most promise. Also, as discussed below, special concessions to LDC imports can help to expand their market share.

Effective Protection

Because tariff rates vary according to products and to stage of processing, the nominal tariff rate is not always a good indicator of the effective protection provided to domestic industries. In the case of processed minerals, the raw materials enter the United States with little or no tariff duty, whereas processed mineral products pay duties in the 8% to 10% range. Thus, domestic mineral processors are able to charge more for their products (because of the tariff protection) but do not have to pay duties on imported raw materials used in production. The net result is that value added in processing and the rate of return on investment are increased. In general, the smaller the share of value added relative to the price received for the product, the greater the effective protection offered by tariff.*

Because the degree of effective protection affects profitability of domestic industries, it is a critical variable to examine when analyzing the impact of tariffs on domestic supplies of processed products and on investment decisions with respect to location of processing facilities. If effective protection is high, mining and processing companies will be more likely to invest in DCs with markets for their products.

Estimates of the degree of effective protection granted to processed aluminum, copper, iron, and steel products are given in Table 52. These estimates are somewhat out of date in that for certain products tariff charges are quoted as cents per pound rather than ad valorem, and mineral prices have generally risen since they were made. For most products, the effective tariff is about 50% higher than the nominal tariff. For steel ingots, which constitute about 1% of steel imports, the effective tariff is estimated to be 62.2%, as compared with a nominal tariff of 6.3%.

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*For example, suppose two products originally sold for $0.91 each and the cost of materials for the first product was $0.50 and for the second $0.81. If a 10% ad valorem tariff was imposed and resulted in the domestic selling price to rise to $1.00 for each product, the value added for the first product would increase from $0.39 to $0.50 or by 28%, and for the second product it would increase from $0.10 to $0.19 or by 90%.

Table 52

NOMINAL AND EFFECTIVE U.S. TARIFFS
FOR POST-KENNEDY ROUND NEGOTIATION
(In Percent)

	SITC No.	Nominal Tariff	Effective Tariff
Iron ore	281.3	0.0%	0.0%
Pig iron, ferroalloys	671	0.7	0.0
Steel ingots	672	6.3	62.2
Rolling mill products	673,676	3.5	-4.8
Other steel products	677	4.0	6.3
Copper ore and concentrates	283.1	0.1	0.0
Copper, unwrought	682.1	2.3	11.2
Bauxite	283.3	0.0	0.0
Alumina	513.6	0.0	0.0
Aluminum, unwrought	684.1	4.0	6.0
Aluminum, wrought	684.2	5.9	11.5

Source: Bela Balassa, The Structure of Protection in the Industrial Countries and Its Effects on the Exports of Processed Goods From Developing Countries. Appendix Table 1. Economics Department, International Bank for Reconstruction and Development, International Development Association (February 28, 1968).

Rolling mill products, however, have a negative effective tariff rate and constitute well over 10% of steel imports. For all manufactured products, the post-Kennedy Round nominal and effective tariffs are, respectively, 6.8% and 11.6%, indicating that on average processed minerals are not treated less favorably than other products.

Generalized System of Preferences

To assist the LDCs in establishing and expanding their manufacturing base, a proposal was made before the first United Nations Conference on Trade and Development (UNCTAD) in 1964 to grant preferential tariff treatment to semimanufactured and manufactured products originating in LDCs. The United States, as part of its Trade Act of 1974 (as have many other developed countries) introduced the "Generalized System of Preferences" (GSP) in 1976. This system allows duty-free treatment on a wide range of designated articles (currently numbering over 2,700) imported directly from any of the 98 countries and 39 dependent territories designated as beneficiary developing countries. Not all manufactured products are included in the GSP, and as shown in Table 53, about 79% of aluminum and 91% of iron and steel products imported into the United States are excluded from GSP. Essentially all copper imports are included under the GSP.

Besides failing to cover all product categories, coverage of the GSP is limited by two competitive need criteria. These criteria can be summarized as follows:*†

- If a developing country supplies 50% or more (by value) of the U.S. imports of a product during the previous calendar year, its imports of that product are excluded from the GSP for the current year.
- If a developing country supplies more than $34.4 million (adjusted upward for inflation each year) of a product to the United States, its imports of that product are excluded from the GSP for the year.

The LDCs have complained about the general terms of the competitive need criteria. Several journal articles have indicated the extent to which further coverage of the GSP could aid these countries.‡ Of the

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*For a more complete description, see U.S. Department of Commerce, Copper, Quarterly Report, Spring 1977, page 3.

†For a list of items for which certain countries are excluded from GSP, see U.S. Trade Commission, Tariff Schedules of the United States Annotated, 1978, page 4 and 5.

‡One recent article is that by Baldwin and Murray, op. cit. According to their results, the benefits accruing to LDCs from the GSP could be expanded by approximately 50% if the competitive need criteria were eliminated.

Table 53

VALUE OF IMPORTS AND GSP COVERAGE
1976

	Aluminum Products*	Copper Products†	Iron and Steel Products‡
All imports (millions of dollars)	552	777	4,572
Percentage of total			
Imports originating in beneficiary countries	11	54	7
Value of all imports in categories included in the GSP**	21	100	9
GSP exclusions from competitive need criteria	0	44	0
Value of beneficiary country imports entering duty free because of the GSP	2	10	1

*Includes products classified in TSUS numbers 618.01 to 618.48.

†Includes products classified in TSUS numbers 612.02 to 613.19.

‡Includes products classified in TSUS numbers 607.01 to 610.81.

§Customs valuation.

**Most aluminum products excluded from the GSP have low duties, of approximately 2% to 3% of value.

Sources: U.S. Tariff Commission, Tariff Schedules of the United States Annotated, 1978; Bureau of Census, U.S. General Imports, Schedule A Commodity by Country of Origin, December 1976; unpublished Census tabulations; and SRI International

three minerals covered in this report, only copper imports are affected by the competitive need criteria. As shown in Table 53, about 44% of the value of processed copper imports (or about 90% of these imports originating in LDCs) were excluded under the competitive need criteria in 1976.

Thus, of a total of about $5.9 billion of imports of processed aluminum, copper, iron, and steel (from all countries), only about $1.3 billion were in categories that even qualified for the GSP and only $0.8 billion were from beneficiary countries. More importantly, duty-free imports under the GSP amounted to only $130 million, or about 2% of total imports and 17% of beneficiary country imports.

In a recent article, Robert Baldwin and Tracy Murray* estimated that the benefits of further reductions of Most Favored Nation (MFN) tariff cuts (such as these being considered under the current round of General Agreement on Tariffs and Trade (GATT) negotiations) would have a beneficial impact on LDC imports even though the margins provided by GSP would be reduced. LDC benefits from GSP arise, in part, because their products become more competitive compared with those from DCs. As MFN tariff rates fall, this tariff differential between developed and beneficiary (LDC) countries also falls. However, because of restrictions and limitations to GSP, the losses due to the erosion of the margins of preference are estimated to equal only one quarter of the gains from further trade expansion from MFN tariff cuts. MFN tariff concessions will, most likely, cover a broader range of products than does the GSP and will not place limits on imports (such as the competitive need criteria) to qualify for them.

The degree to which further GSP concessions can help forward processing of minerals in LDCs is uncertain. Potential increases in prices received by producers of refined mineral products originating in the LDCs could arise from further GSP concessions and would have a positive impact on the profitability of large-scale investment projects. But the political pressures not to contract certain industries in the United States based on concern for American jobs that might be lost due to increased imports of mineral products remain major obstacles to the inclusion of new product categories in the GSP.

Other Trade Barriers

In general, U.S. agencies impose few impediments to trade in mineral products other than tariffs. The ongoing impediments, having only minor effects on imports, are government procurement restrictions (or Buy American laws) and restrictions on highly specialized mineral products covered under the National Security Amendment.

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*Robert E. Baldwin and Tracy Murray, op. cit.

The reference or minimum pricing instruments for iron and steel imports establish a minimum price for imports (based on Japanese steel production costs). Imported products priced below the reference price are penalized sufficiently through the rapid imposition of tariffs. The current trigger price mechanism, introduced about a year ago to expedite anti-dumping measures, protects domestic industries from products priced below costs of production. However, as noted in a study conducted by the Federal Trade Commission,* reference pricing mechanisms prevent the pricing flexibility of steel products over the business cycle; during periods of low demand, reference pricing prohibits firms from selling at prices that cover their variable costs but are still below the reference price. This study concludes that the reference pricing mechanism forces foreign iron and steel companies to behave as if they were a cartel and, consequently, foreign producers are receptive to the idea.

Because reference prices are based on Japanese production costs, the value of the yen relative to the dollar affects the level of prices set. The boost in trigger prices scheduled for July 1, 1978, reflects the appreciation of the yen as well as higher costs for Japanese steel.† The impact on products of countries whose currencies have not appreciated against the dollar as much as the yen will be to raise the effective price they receive, thus preventing the competitive advantage they would normally gain as their currencies depreciate against the yen.

To a limited extent, reference pricing may hinder forward processing, because the LDCs may not be able to set prices at a level sufficiently low to be competitive on world markets. LDCs often lack the marketing organization to sell their products effectively in industrialized countries. Moreover, the quality of LDC products and their delivery reliability are generally inferior to those of the dev loped countries.

Certain trade impediments arise on a temporary basis. For example, temporary quotas currently exist on specialty steel imports; they went into effect in 1976 and are scheduled to be removed in June 1979, unless extended. Brazil, Argentina, and Korea ship specialty steel to the United States and may be affected by these quotas.

Orderly marketing agreements (OMAs) are voluntary quantitative restrictions on imports. Because of their voluntary nature and that they are imposed by the exporter, OMAs circumvent the basic rules of GATT. In the past, OMAs were more prevalent, but now the only ones involving minerals are with Japan on specialty steel products. Meetings of top officials from the United States, European Economic Community, and Japan are

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*Federal Trade Commission Staff Report on The United States Steel Industry and Its International Rivals, November, 1977.

†For a more complete discussion, see The Wall Street Journal, "Treasury Boosts 'Trigger' Levels for Steel Prices," May 8, 1978, page 2.

being conducted on international steel trade. The aim of these meetings is to prevent price cutting in steel products and to put order into the international steel markets. A result of these meetings may be further extensions of OMAs to include most of the industrialized world.

There was recently a prospect of restrictions on imports of basic copper shapes to protect domestic industries. The International Trade Commission prepared a report on the subject in late 1978 and decided not to protect the copper industry any further.

In 1973-1974, the United States imposed restrictions on scrap steel exports to limit foreign demand in an effort to reduce pressure on domestic prices. A statement by the United States that it does not intend to reintroduce export controls on scrap steel could serve as an incentive to some LDCs to consider investment in scrap-based minimills. Smaller scale, electric furnace steel plants which use steel scrap are often the most economical for LDCs. Because the United States is the principal world source of scrap, U.S. restrictions on exports, even if temporary, cause a major dislocation in countries dependent on scrap.

Incentives for Private Companies to Invest in LDCs

Background

Mineral exploration, mining, and processing require large amounts of investment capital. Historically, this capital has been provided by large mining companies, and ownership and control have been concentrated in their hands. For the LDCs, this type of investment and operation resulted in foreign control of their natural resources. In recent years, the LDCs have demanded a principal role in the exploitation of their natural resources, with the result that many mining operations have been nationalized, or have experienced a wide variety of problems that greatly reduced their profitability. As a consequence, large mining companies find that the risks of exploration and investment are too great in the LDCs and are concentrating their investment spending in DCs. Table 54 presents the level and distribution of capital expenditures between developed and developing countries of majority-owned affiliates of U.S. companies from 1970 to 1978, and Table 55 shows the value of U.S. foreign direct investment in mining and smelting from 1960 to 1975. It is clear that investment spending and asset accumulation are being directed away from the LDCs and toward the DCs, with Australia, Canada, South Africa, and the United States receiving about 80% of the total.

The disturbing feature of this trend is that the LDCs have found that participation by large, international mining companies is critical to mineral exploration, mining, and processing. The LDCs lack the technical experience and capital to undertake large-scale exploration and investments by themselves and have difficulty borrowing sufficient funds from private sources. Because of the problems described above, the shares of world output of iron ore and of bauxite produced in the LDCs have been declining.*

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*Estimates based on data from U.S. Bureau of Mines and Metallgesellschaft, A.B., Metal Statistics.

Table 54

MINING AND SMELTING: CAPITAL EXPENDITURES
BY MAJORITY-OWNED FOREIGN AFFILIATES
OF U.S. COMPANIES
1967-1978
(Millions of 1967 Dollars)*

	Developing Countries	Developed Countries	Total
1970	392	621	1,113
1971	287	998	1,285
1972	239	811	1,050
1973	169	587	756
1974	197	477	674
1975	198	473	671
1976	123	363	486
1977	54	291	346
1978†	51	278	328

*Deflated by U.S. wholesale price index 1967 = 100.

†Projected.

Source: "Capital Expenditures by Majority-Owned Foreign Affiliates of US Companies," Survey of Current Business, Washington, D.C.: U.S. Department of Commerce, March 1978, March 1977, March 1976, March 1975, March 1974, and December 1973; and Raymond F. Mikesell, "Foreign Investment in Nonfuel Minerals; Outlook and Policy Issues," mimeographed, University of Oregon, 1977.

Table 55

MINING AND SMELTING: VALUE OF U.S. FOREIGN DIRECT INVESTMENT
1960, 1965, 1970, and 1975
(Millions of Current U.S. Dollars; End of Period)

	Developing Countries	Developed Countries	Total
1960	1,600	1,411	3,011
1965	1,814	1,971	3,785
1970	2,522	3,646	6,168
1975	2,145	4,407	6,552

Source: Survey of Current Business, Washington, D.C.: U.S. Department of Commerce, various issues.

Investment requirements in aluminum (including bauxite and alumina), copper, and iron and steel facilities throughout the world over the period 1976 to 1985 are expected to amount to $149 billion (1975 U.S. dollars) or about 83% of the required investment for nine important nonfuel minerals.* The World Bank estimates that approximately 53% of the investment requirements for all nine minerals will be for facilities in the LDCs.† Therefore, it is important that attention be given to means of increasing foreign direct investment in the LDCs.

Overseas Private Investment Corporation

Significant proportions of resources available from the World Bank and various regional development banks until recently have not been made available to mining sector investments.‡ Mineral developments typically have large-scale financial requirements. For example, the capital cost for a minimum economic-size alumina facility is estimated at $200 to $260 million by SRI, and for a minimum-sized aluminum facility at $144 to $216 million.

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*From IBRD Commodities and Export Projections Division, Economic Analysis and Projections Department. The nine minerals examined include the three mentioned above plus nickel, lead, maganese ore, phosphate, rock, tin, and zinc.

†World Bank, Minerals and Energy in the Developing Countries, May, 1977, page 12.

‡Raymond F. Mikesell, "Foreign Investment in Nonfuel Minerals: Outlook and Policy Issues," mimeographed, University of Oregon, 1977.

The U.S. Government has helped to insure equity holding of multinational corporations from noncommercial losses through the Overseas Private Investment Corporation (OPIC). OPIC covers a wide variety of overseas investments. Its current coverage of minerals projects is small, but in the past, minerals projects have represented larger portions of the OPIC portfolio. Reduction in U.S. direct investment in mining and processing in LDCs, as discussed above, and problems associated with Anaconda, as discussed below, may have resulted in reduced use of OPIC's services. Consequently, OPIC has not insured a major nonfuel minerals project since 1971. Smaller scale nonfuel mineral projects currently insured by OPIC are:*

Company	Country	Project	Total Insured Investment of This Investor
Dresser Industries	Greece	Mining and processing of barite and bentonite (expansion)	$459,000
The Hanna Mining Co.	Brazil	Manufacturing of aluminum ingots (expansion)	$1,263,136
Production Machinery Corp.	Yugoslavia	Cold steel rolling mill	$535,050
Waterbury Farrel	Yugoslavia	Cold steel rolling mill	$258,000

Even though its past coverage of nonfuel mineral projects has been limited, OPIC wants to expand its operations in this area. OPIC itself has summarized the difficulties in promoting U.S. direct investment in mineral mining and processing in LDCs as:†

- Depressed prices in copper, nickel, and some other metals
- Soaring costs of capital plants and energy
- Uncertainties as to future cost-price relationships.

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*Overseas Private Investment Corporation, 1977 Annual Report.

†Taken from a September 20, 1977, Memorandum to the Board of Directors (of OPIC) from the Minerals and Energy Group on the subject of OPIC minerals policy.

However, OPIC recognizes that political risks further reduce potential profitability of investment. Foreign mineral companies were among the major targets of LDC economic nationalism in the late 1960s. Furthermore, mining company confidence in OPIC to offset these political risks through insurance may have been weakened by the prolonged problems in settling Anaconda's claims and by current problems with Revere,* but it is not clear whether these cases can be considered typical of the claims most companies are likely to make.

To help counter the problems in promoting U.S. direct investment mineral mining and processing in the LDCs, OPIC has established a new program that:†

- Revises insurance service and terms.
- Expands finance services to minerals investors.
- Encourages cooperation and collaboration with other national, international, and private agencies and insurers.
- Maintains contact with industry associations and companies.

There has been essentially no industry response to the existing and proposed OPIC policy changes. Consequently, it is difficult to determine whether, in the future, OPIC will have a more positive impact on forward processing in LDCs. But planned closer coordination of OPIC with industry should result in more use of this service.

The OPIC bill passed by Congress early in 1978 generally conformed to the recommendations of the OPIC Board. Although no specific provisions were included in the bill requiring special attention be given to promoting nonfuel mineral mining in the LDCs, general guidelines were included stating that OPIC should encourage expansion of mutually beneficial private investment in minerals, energy, and related processing

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*The Anaconda case involved copper mines nationalized through an agreement between Anaconda and the Chilean government. OPIC claimed that the voluntary nature of the agreement and the fact it fundamentally altered the nature of the operation, abrogated the terms of OPIC insurance. Furthermore, the insurance policy had not been kept current, but was paid up at a later date. However, the decision was in favor of Anaconda.

The Revere case, currently in arbitration, involves an aluminum facility in Jamaica. Revere claims that certain acts by the host government had an expropriatory effect on their operation. OPIC is resisting the claim because it believes the problems associated with Revere's plant were commerical in nature and not as a result of actions covered in the OPIC policy.

†OPIC Memorandum of September 20, 1977, op. cit.

industries. Priorities also are to be given to small businesses and to lower income LDCs, but these priorities do not affect that for minerals, energy, and related processing industries. One amendment was added, however, that precludes support of any copper project before 1981, and after 1981, support cannot be given to a copper project if it can harm the U.S. industry. This type of protection to the copper industry is in line with the special report being developed by the International Trade Commission that could lead to increased trade barriers placed on copper product imports into the United States. Clearly, any additional protection to the U.S. copper industry would have a negative effect on LDC processing.

OPIC coverage for a single project is limited to $150 million. This figure is insufficient for most large minerals projects that can often reach $500 million. For a multilateral venture, companies can obtain political risk insurance from other sources, including the 18 other national insurance companies. Rates for OPIC insurance are determined on a case-by-case base, with insurance rates of approximately 1.0% to 2.0% of the amount insured per year.*

Because the current U.S. policy efforts to promote foreign direct investment in mineral processing in LDCs have not been successful, some further changes are warranted. It is not clear what policies should be implemented as, according to one source, "... no special arrangements for promoting foreign private investment are likely to prove successful in the absence of the willingness of the governments of developing countries to abide by their covenants."† Most mining companies like to feel fairly certain about tax and other conditions prior to any heavy investment and insist on some agreement with the Government that these conditions will not be changed over a time period sufficient for them to recover their capital plus a rate of return. This rate of return is often 20% to 25% before taxes on all risk capital.‡ However, as it takes several years before revenues are forthcoming, this rate of return may require a ratio of annual earnings to equity investment of 35% to 40%. Often such rates of return appear unreasonable to host governments.

Tax Policies

Tax policies can affect the profitability of investing overseas. Existing tax policies that help to reduce the burden of foreign operations are:§

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*The basic fees are as follows: 0.9% for expropriation coverage; 0.6% for war, revolution, and insurrection coverage; and 0.3% for inconvertibility coverage. These basic rates may be increased or decreased by up to one-third, depending on the risk profile of a specific project.

†Raymond F. Mikesell, op. cit., p. 32.

‡Ibid, p. 13.

§Joseph A. Pechman, Federal Tax Policy, third edition, Washington, D.C.: The Brookings Institution, 1977, pages 160-162.

- The allowance of a credit against the U.S. tax for any tax paid on these dividends up to the U.S. tax liability on that income.
- Deferment of tax paid on income of foreign subsidiaries until repatriation.
- Measurement of dividends from corporations in LDCs net of foreign tax, yet the recipients are entitled to a full tax credit for any foreign income tax.
- The exclusion of $15,000 of earned income from U.S. tax of U.S. citizens working abroad.

The Tax Reform Act of 1976 resulted in a series of changes that adversely affected international business and increased the tax burden on multinational corporations. Thus, this Act tends to discourage investment abroad. Major changes relevant to mineral mining and/or processing in tax policy arising from the Act are:*

- "Foreign subsidiaries can invest excess funds in certain U.S. property without the imposition of tax on the U.S. parent company."
- "The amount of deferrable income from export sales of a DISC (Domestic International Sales Corporation) is reduced."
- "The reduced tax rate for U.S. corporations operating outside the U.S. in the Western Hemisphere will be increased from 34% to 48% over a four-year period."
- "U.S. citizens working abroad can exclude only $15,000 of earned income from U.S. tax (formerly up to $25,000). In addition, no foreign tax credit is allowed with respect to the excluded $15,000 and the $15,000 is included in income to determine the marginal tax rates on taxable income."

As more and more LDCs establish their own processing operations, use of mining companies as consultants most likely will increase. Professional expertise and technical information are labor-intensive service exports that often require U.S. personnel to work overseas. The higher tax burden of U.S. citizens working overseas, arising from the Tax Reform Act of 1976, increases the cost of U.S. companies providing this type of assistance and generally makes U.S. personnel less competitive with personnel from other DCs.

Policies of Other Developed Countries

Nominal Tariffs

Policies of other DCs promoting or inhibiting forward processing of minerals in the LDCs appear very similar to those of the United States.

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*From Price Waterhouse, Tax Reform Act of 1976, Information Guide, November 1976, supplement, pages 7-9.

Table 56 presents the tariff rates of Organization for Economic Corporation and Development (OECD) countries for ores, metals, and metal manufacturers. U.S. tariffs are lowest for metal manufacturers but are highest for ores and metal wastes. Japan has the lowest tariffs for iron and steel products but facilities there produce low-cost, high-quality products that compete effectively in international markets. In general, the tariff structure of the United States is no more, and probably less, unfavorable to forward processed minerals in LDCs than are the tariff structures of other OECD countries.

Effective Tariffs

Effective tariff rates of selected DCs computed by Bela Balassa in 1968 are presented in Table 57. As these estimates are based on the Kennedy Round Negotiated tariff structure, they are relatively close to the current tariff situation. With the exception of Sweden, the DCs covered have a higher (unweighted) average effective tariff for processed minerals than does the United States (as can be determined from comparison of Tables 57 and 58). Japan tends to have the highest effective tariff rates on all products with the exception of steel ingots.

Generalized System of Preferences

Nineteen OECD members (including the United States) have enacted the Generalized System of Preferences in one form or another. Lists of products covered by, beneficiary countries included in, and restrictions to the system differ from country to country and, consequently, so do the benefits received by the LDCs. Summarized below are the major characteristics of the GSP among the various DCs.*

- Totally duty-free treatment is given by Finland, Norway, Sweden, and the United States.
- Generally duty-free treatment with some exceptions is given by Japan, Switzerland, and the EEC.
- Duty-free treatment for some products (but the general rule is less than duty-free treatment) is given by Australia, Austria, Canada, and New Zealand.
- Global tariff quotes or ceilings for particular products are used by 3 countries while maximum amounts for individual beneficiaries are used by 2 countries.
- Exclusions according to prescribed conditions (such as the competitive need criteria) when certain beneficiary countries are considered to be competitive on world markets are used by 2 countries, and reduced product coverage for specified beneficiaries is used by 6 countries.

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*Jacques de Miramon and Anthony Kleetz, "Tariff Preferences for the Developing World: Operation and Evolution of the Generalized System of Preferences," OECD Observer, January 1978.

Table 56

WEIGHTED AVERAGE MFN TARIFF RATES FOR ORES AND METAL WASTES, IRON AND STEEL, NONFERROUS METALS, AND METAL MANUFACTURERS
(Percent Ad Valorem)

	Ores and Metal Wastes*	Iron and Steel	Nonferrous Metals*	Metal Manufacturers*
Canada	0.0	7.6	2.5	10.5
United States	1.3	6.6	2.7	7.7
Japan	0.0	5.5†	6.1†	8.9
United Kingdom	0.0	9.7	1.4	11.9
European Community	0.0	6.3	1.7	8.0

*Includes minerals other than those covered in this report.

†Does not reflect unilateral reduction made in 1972 or most Japanese rates in this sector.

Source: United States Tariff Commission, Trade Barriers, Part 3, Major Industries Product Sectors: Tariffs and Other Trade Barriers, April 1974.

Table 57

NOMINAL AND EFFECTIVE TARIFFS OF SELECTED DEVELOPED COUNTRIES FOR POST-KENNEDY ROUND NEGOTIATION

	SITC No.	Japan		United Kingdom		Sweden		European Community	
		Tariff Rate		Tariff Rate		Tariff Rate		Tariff Rate	
		Nominal	Effective	Nominal	Effective	Nominal	Effective	Nominal	Effective
Iron ore	281.3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Pig iron, ferroalloys	671	1.9	2.9	0.8	-2.9	0.0	-4.3	4.0	3.5
Steel ingots	672	6.4	16.6	9.4	88.8	3.8	41.1	4.0	1.1
Rolling mill products	673,676	8.9	20.5	7.4	3.6	5.1	12.6	5.5	11.5
Other steel products	677	7.8	8.6	12.1	31.3	5.0	8.6	7.5	19.5
Copper ore and concentrates	283.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper, unwrought	682.1	7.0	43.1	3.3	15.6	0.0	-1.2	0.0	-5.6
Copper, wrought	682.2	17.8	34.9	9.2	18.0	2.0	2.2	8.0	10.5
Bauxite	283.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alumina	513.6	0.0	0.0	9.6	9.6	0.0	0.0	5.6	5.6
Aluminum unwrought	684.1	10.4	11.4	2.5	-2.3	0.0	0.0	5.8	5.6
Aluminum wrought	684.2	13.6	29.0	9.1	22.1	2.0	5.3	12.8	29.3

Source: Bela Balassa, The Structure of Protection in the Industrial Countries and Its Effects on the Exports of Processed Goods from Developing Countries. Appendix Table 1. Economics Department, International Bank for Reconstruction and Development, International Development Association, February 28, 1968

- Reduced preferential margins for specified beneficiaries are applied by 2 countries.
- A general safeguard clause is used by 10 countries.

Japan has the least product coverage under the GSP; in 1975-76, only about one-quarter of Japan's imports were included in the GSP, and only about 85% of those had duty-free coverage.* Switzerland's coverage is limited to about 45%, whereas the other OECD countries (other than the United States) generally cover 70% or more of imports in the GSP.

The EEC does not have competitive need criteria similar to those of the United States, but it does have a quota system that is generally more restrictive. Basically, each member country has a quota for each product that covers imports from all beneficiary countries. There is no clear allocation system for beneficiary countries and, consequently, imports of products with quotas receive duty-free or duty-reduced treatment basically on a first-come-first-served basis.

Specific GSP provisions for some categories of iron, steel, copper, and aluminum products of selected OECD countries are presented in Table 58, along with the respective tariff rates. Japan's tariffs are generally the highest, but all products are included in a GSP scheme that allows duty-free entry. However, Japan does place quantitative limits that diminish the trade-inducing impacts of the GSP. Sweden tends to have the lowest tariff rates and the lowest restrictions to its GSP scheme; only iron and steel semimanufactured products are not fully covered. Canada and Australia apply either a reduced tariff (but not duty-free coverage) or quantitative restrictions to minerals. The EEC, as mentioned previously, places ceiling limits on all products, and its product coverage with respect to processed minerals is incomplete except for iron, steel, and aluminum semimanufactured products. The U.S. scheme is included for comparison, and it appears to be less restrictive than some and more restrictive than others.

Other Trade Barriers

Complaints against the European Community also include government aids to domestic production and exports of steel, licensing requirements, government procurement practices, and preferential treatment to certain countries.†

Complaints against policies in Japan that inhibit trade include: subsidies and other aids, quotas, high tariffs, licensing practice, state trading and government monopolies, restrictive business practices, and

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*Ibid.

†U.S. Tariff Commission, Trade Barriers, Part 1: Trade Barriers: An Overview, April 1974.

Table 58

GSP SCHEMES OF DEVELOPED MARKET ECONOMIES FOR IRON, STEEL, COPPER, AND ALUMINUM PRODUCTS

	EEC*		Japan†		Canada		Sweden		Australia		United States	
	Tariff (%)	GSP Status	Tariff (%)	GSP Status	Tariff (%)	GSP Status	Tariff (%)	GSP Status	Tariff (%)	GSP Status	Tariff (%)	GSP Status
Iron and steel, unworked	4.5	PT	5.5	F	12.5	INC	3.4	F	0.0	INC	4.5	F
Iron and steel, semimanufactured products	6.8	F	10.2	F	10.4	INC	5.9	PT	16.6	INC	7.8	PT
Ferro-alloys	5.6	EXC	7.5	F	7.2	INC	2.3	F	0.0	INC	5.6	F
Copper, semi-manufacturers	7.4	PT	16.5	F	9.3	INC	3.1	F	15.0	INC	8.0	INC
Aluminum, semi-manufacturers	10.9	F	14.9	F	13.2	INC	3.2	F	6.0	INC	7.7	F

Key:

PT: Part of the items in the group admitted free of duty while others subject to general tariff rates.
INC: All items in the group granted preferential treatment but not at zero rate and/or subject to quantitative restrictions.
F: All items within product group are admitted free of duty.
EXC: All items in the group excluded from the scheme.

* All imports under the EEC scheme are subject to ceilings.
† Most of the products are subject to restrictive ceiling limitations for safeguard reasons.

Source: Zubair Iqbal," The Generalized System of Preferences Examined," Finance and Development, Vol. 12, No. 3 (September, 1976), Table 1.

miscellaneous taxes. Canadian tariff rates receive numerous complaints, and a 12% manufacturer's sales tax imposed at the border is considered to impede trade.*

Developed Country Policies--Summary and Conclusions

DC policies that affect forward processing of minerals are grouped into two categories: (1) trade barriers and (2) incentives to invest in LDCs. Most trade barriers are related to tariffs in one form or another, although quotas, orderly marketing agreements, and similar actions do inhibit imports of processed minerals into DCs. Because of reduced sales in international markets arising from trade barriers, the incentives for locating processing facilities in LDCs are reduced. Policies that promote investment in LDCs generally operate by providing incentives for multinational mining companies to locate plants in LDCs. Availability of insurance to protect against noncommercial losses, such as nationalization or war, is provided to U.S. companies by Overseas Private Investment Corporation (OPIC), a government agency. Other similar organizations exist throughout the world. Tax incentives are another means of promoting foreign direct investment in LDCs. Currently, U.S. tax policies do not especially promote investment in minerals processing in the LDCs.

The major conclusion from this analysis is that on balance U.S. policies tend to be slightly negative with respect to encouraging forward processing in the LDCs. Furthermore, the U.S. policies are similar to those of other DCs and should not be singled out as being excessively unfavorable. Some policies do act to hinder forward processing, while some help. However, it is clear there is room for some improvement of U.S. Government policies, especially with respect to tariffs, that would further encourage the development of the minerals processing sectors in the LDCs.

Tariff structures of the United States and of other DCs have a negative influence on forward processing inasmuch as processed materials are subject to duties of the magnitude of 8% to 10% ad valorem, whereas most crude ores are subject to substantially lower, often zero, duties. Effective protection afforded to domestic producers of mineral products by the existing tariff structure is about 10% to 12%. Some relief from higher tariffs on processed minerals is given to the LDCs in the form of Generalized System of Preferences (GSP) that allow certain products of LDCs to enter without paying tariff duties. However, the GSP is fairly limited in coverage and excludes many of the processed minerals of LDCs.

A summary of those DC policies found to most affect forward processing in the LDCs is given in Table 59. Of the four trade policies listed, three tend to inhibit forward processing and one tends to promote it. The investment policy listed promotes, and the tax policy shown acts to discourage direct foreign investment and loans by multinational corporations in LDCs.

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*Ibid.

Table 59

DEVELOPED COUNTRY POLICIES THAT AFFECT MINERALS PROCESSING

Policies	General Applications	Specific Examples
Trade		
Nominal tariffs	Tariffs set to inhibit imports of products into DCs	Tariffs of about 7% charged on steel product imports
Effective protection	No or very low tarrif for raw materials; higher tariffs for processed materials	No tariffs on bauxite or alumina imports; tariffs of 6% on wrought aluminum imports
The generalized system of preferences	Elimination or reduction of tariffs or products produced in LDCs	20% of LDC exports of copper products to United States enter duty-free
Nontariff barriers	Inhibit imports of products into DCs	Reference or minimum pricing for iron and steel imports
Investment		
Investment guarantees and insurance	Risk insurance for companies and banks investing in LDCs	Insurance covering $1.3 million in U.S. company aluminum ingot manufacturing plant in Brazil
Tax		
Income tax	U.S. tax policy changes rate of return on investment for U.S. companies' investments in LDCs	Because of 1976 Tax Reform Act, reduced tax rate for U.S. corporations operating in Latin America will be eliminated.

A variety of nontariff barriers tends to discourage forward processing in the LDCs. The goal of these barriers is to protect domestic industry and reduce competition from abroad, including that from the LDCs. Complaints against DC trade policies include regulations requiring government agencies to purchase domestic products (e.g., Buy American laws), orderly marketing agreements on some steel products, and licensing arrangements. The result of research recently conducted by the International Trade Commission is that protection of the U.S. copper products industry will not be increased in the near future.

The negative impacts of DC's trade barriers on forward processing are probably small in comparison to the problems associated with encouraging direct investment of the large multinational companies in mineral mining and processing facilities or with obtaining adequate financing and technical skills for the LDCs to build their own facilities. Risks of noncommercial losses have been a major deterrent to the flow of investment capital to the LDCs, with the result that most new mines and plants are being built in the DCs. To date, the OPIC insurance program has not successfully encouraged foreign direct investment in forward processing of nonfuel minerals in LDCs, and recent changes in its proposed coverage of mineral processing plants have not had time to elicit any response, either positive or negative, from the mining industry. Furthermore, prohibition of coverage of copper projects until 1981 included by Congress in the recent OPIC Bill indicates that domestic industry interests often supersede U.S. aid to the LDCs.

International Financial Institutions

In May 1977, the World Bank completed a special report on "Minerals and Energy in the Developing Countries.* With respect to nonfuel minerals, the report concluded that the family of international financial institutions should provide greatly expanded financial and technical resources to the LDCs. In the past, such assistance had claimed only a minor part of the bank resources. The World Bank has since adopted a policy of greatly expanded support.

SRI agrees that such assistance should be increased and would assist in increasing LDC minerals processing. However, it is clear that financial assistance to specific countries or investors should be coupled with reform of policies by recipient LDCs which tend to inhibit investment and production. Import policies and foreign investment support programs by the United States and other DCs which serve to limit markets or the flow of private resources run counter to the objectives of additional World Bank and other public agency financing and limit the effectiveness of such efforts.

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*Report No. 1588.

VII FINDINGS

Trends in Minerals Processing in Less-Developed Countries

1. LDCs are expected to increase their share of world first-stage copper processing (smelting) from 35% in 1975 to 42% in 1985 and second-stage processing (refined copper) from 24% to 34% (see Table 60).

2. Modest growth from 19% in 1975 is expected in the LDC share of alumina production, but the share of aluminum production is expected to increase from 7% to 16% by 1985 (see Table 60).

3. For iron ore processing, LDCs share of first-stage (pig) and second-stage (steel) processing is expected to grow from 10% to 11% in 1975 to 15% to 16% by 1985. Most of the growth in iron processing will be in the larger LDCs to serve their domestic markets (see Table 60).

4. The increases in minerals processing are forecast on the basis of no substantial change in current DC or LDC policies or in the general investment climate that exists in the principal LDC mineral countries. For the most part, policy changes described below would not be expected to affect production before 1985.

5. Policy analysis of mineral processing cannot be performed effectively in the aggregate or by stage of processing. It requires commodity-by-commodity economic analysis by stage of processing and then country-by-country review of specific policies in both DCs and LDCs. The more aggregate the level of analysis, the less accurate will be its results.

6. The economics of locating minerals processing facilities differ by mineral and by stage of processing. For aluminum, substantial efficiencies are achieved by processing bauxite to alumina at or near the bauxite source; but processing of alumina to aluminum is dependent on low-cost energy and may be done away from the alumina site. For copper, two-stage processing of ore into smelted and refined is now done economically at or near the location of the ore. For iron and steel, the ore can be exported or processed to pig iron and exported, but there is little export market for steel manufactured in developing countries (see pages 9, 19, and 29).

7. No evidence was found to indicate that social returns from minerals processing are substantially in excess of private returns. This does not necessarily mean that significant social benefits do not exist. They may be present either on the project level or in countries other than those examined. The employment, income redistribution, linkage, and balance of payment benefits, did not, however, appear to be very large.

Table 60

LESS-DEVELOPED COUNTRIES' SHARE OF WORLD MINERALS PRODUCTION
BY STAGE OF PROCESSING AND WORLD CONSUMPTION
1955-1990
(In Percent)

	Mine Production			Stage I Processing			Stage II Processing			Consumption		
	Bauxite	Copper	Iron	Alumina	Smelter Copper	Pig or Sponge Iron	Aluminum	Refined Copper	Steel	Aluminum	Copper	Steel
1955	--	14	13	--	37	5	--	17	3	--	4	7.8
1960	58.5	46	27	--	39	15	1.0	19	9	2.7	6	12.2
1965	56.6	43	29	15.6	37	10	2.1	20	7	4.0	7	10.5
1970	54.4	41	30	20.1	34	9	3.7	21	8	5.4	7	11.9
1975	47.8	45	34	18.6	35	11	7.4	24	10	7.3	12	13.4
1980	*	45	34	19.2	38	11	8.5	29	12	6.9	12	17.3
1985	*	49	36	22.1	42	15	16.2	34	16	7.4	15	19.6
1990	*	51	39	--	44	19	--	37	21	--	18	22.3

*Slight decline.

Source: SRI International

8. LDC tax revenues from mineral processing are substantial in most developing countries only when they are related to revenues from taxes on ores. The economic rents from natural resource production can be realized only once. Countries which mine but do not process their ore thus will not receive greater rents than those which both mine and process.

Policies in Less-Developed Countries

1. The underlying economic characteristics of specific mineral technologies, costs, and markets provide the key determinants for the location of processing facilities. LDC policies can influence but, within reasonable policy limits, cannot determine the location of such facilities. In most cases, private returns must be adequate before policies influence minerals investment decisions. Iron ore production in Liberia without processing shows this to be the case.

2. LDC policies can influence the level of investment in local mineral extraction, which in some cases also influences the level of investment in local processing facilities. The influences vary substantially by mineral, country, and policy.

3. LDC policies have most influence on minerals and processing investment at the initial stages of investment consideration. Once capital equipment and personnel for minerals projects are in place, small changes in LDC policies are less likely to influence continuing investment in the minerals sector.

4. In the case of second-stage bauxite processing or first-stage iron ore processing, the economic disadvantages of locating facilities near the prior stage cannot be overcome without very substantial subsidies. Government policies have their strongest effects on first-stage bauxite processing and copper processing, where it is most economical to locate processing plants close to the mine site (see page 58).

5. Because of the long period of time needed for construction and operation, stability of policy rather than the specific characteristics of any single policy or policy change is probably more important in the long run because it affects investment decisions. A stable minerals policy is critical to the promotion of foreign private investment because investors place the major emphasis on a stable and an adequate rate of return. Further, the combination of policies directly or indirectly affecting mineral investment and processing investment in most cases is far more important than any single, specific mineral-related policy. The "investment climate" is in a large part made up of these factors.

6. Among the LDC macropolicies affecting minerals processing, monetary, exchange rates, and tax policies appear to be most important; labor and employment policies are important, and trade and investment policies appear least important. Expropriation inhibits further private investment, and because large capital resources are required for mineral investment, such actions may also deter financing of substitute investment by the public sector (see Table 61).

7. The effects of policies are usually felt in both the long run and the short run, although some policies are predominantly long-term oriented (see Table 62).

8. The case studies of Zambia and Jamaica indicate that some policies will increase the short-run and long-run profitability of minerals processing which is susceptible to policy changes (i.e., first- and second-stage copper processing and first-stage bauxite processing). These policies are:

   - Less overvalued exchange rates
   - Increased availability of credit
   - Reduced levels of taxation.

   Other policies will increase predominantly the long-run profitability only because of the time needed for the policy impact to be spread throughout the economy. Long-run oriented policies are:

   - Provision of adequate infrastructure
   - Increased training of nationals
   - Attractive wages for minerals processing personnel.

   The increased profitability from the above policies would tend to increase the quantity of processing in the LDCs, all other things being equal. The DCs may also be affected through heightened international competitiveness caused by higher returns in the developing countries.

9. Other policies reduce profitablity and production of minerals processing in LDCs. At a minimum, the economic efficiency of such operations will deteriorate, possibly necessitating subsidization. DC processing operations would appear more attractive and may thus be increased. The return-reducing policies are:

   - More overvalued exchange rates
   - Reduced availability of credit
   - Increased levels of taxation
   - Inadequate provision of infrastructure
   - Reduced training of nationals
   - Inadequate wages for minerals processing personnel.

Table 61

LDC POLICIES THAT IMPACT MINERALS PROCESSING BY STAGE OF PROCESSING

Mineral Stage of Processing	Monetary and Capital		Fiscal			Labor		Trade and Investment		Other	
	Exchange Rate	Credit	Infra-structure	Sub-sidies	Tariffs and Taxes	Training	Wages	Tariffs, QRs, NTBs	Owner-ship	Bauxite Levy	Expro-priation
Copper											
1st stage	X	X	X	X	X	X	X	X	X		X
2nd stage	X	X	X	X	X	X	X	X	X		X
Bauxite											
1st stage	X	X	X	X	X			X	X	X	X
2nd stage			X							X	X
Iron Ore											
1st stage				X	X			X	X		X
2nd stage				X	X			X	X		X

Table 62

LONG-RUN VERSUS SHORT-RUN IMPACTS OF LDC POLICIES

	Monetary and Capital		Fiscal			Labor		Trade and Investment		Other	
	Exchange Rate	Credit	Infra-structure	Sub-sidies	Taxes	Training	Wages	QRs NTBs	Owner-ship	Bauxite Levy	Expro-priation
Impacts felt in short and long run	X	X		X	X		X	X	X	X	X
Impacts felt predominantly in long run			X			X					

In Zambia and Jamaica, these policies appeared to have more immediate and stronger impacts than the return-raising policies.

10. The bauxite levy acts specifically to reduce the returns from bauxite mining and perhaps alumina and aluminum production. All other things being equal, this policy imposed by a LDC in the long run will shift such production away from the countries that impose the levy. In the long run, bauxite-producing DCs should benefit. In the short run, however, the bauxite levy has the potential for raising social returns to the bauxite-producing countries while reducing the returns to DC investors.

11. The effects of expropriation policies of LDCs vary, but in the long run would be expected to shift production away from the developing to the developed countries. The short-term effects of expropriation are uncertain. The economics of expropriation may be overlooked so that political or social objectives receive priority. If foreign investment or skill is needed for the minerals production, however, expropriation will decrease the long-run LDC processing and thus increase the DC processing.

12. Other LDC policies, such as trade and investment policies, have less noticeable impacts on both the LDCs and the DCs. No major impacts from these policies were observed in the countries studied. Import restrictions and protective tariffs are effective in securing a large domestic market for domestic production. However, such policies do lead to high-cost goods.

Policies in Developed Countries

Three general types of developed country policies are identified in this analysis--trade, investment, and tax policies--with more specific policies included within each category. A series of specific findings relating DC policies to forward processing of aluminum, copper, iron, and steel in LDCs is given below. These findings support the general conclusion that DC policies, on balance, tend to have a slightly negative impact on forward processing in the LDCs.

- Impacts of Tariffs

  1. Reductions in U.S. tariffs on copper products would provide general support for additional processing or revenues in LDCs. In 1976, 54% of U.S. copper imports came from LDCs, and over 80% of these imports were subject to duties averaging about 2.3% ad valorem. Effective tariffs on copper products are estimated to equal over 11%. Added revenues from copper product sales to the United States and other DCs from reduced tariffs should provide some additional funds and foreign exchange to help in financing new and maintaining existing processing facilities. Chile, Zaire, and Peru do not process all of their copper at the present time, but

Zambia does. Thus, the first three countries have ore available to use if copper refining and smelting capacity is expanded. However, the problem of world copper prices is considered a more significant deterrent to expanding facilities in LDCs than are the current DC tariffs. Copper prices are depressed at present, and until they reach levels at which mines can operate more profitably, production of ores and of processed copper will be limited. For example, in Zambia several mines are losing money (up to $200 per ton), but as of September 1, 1978, closures have not taken place because of government policy decisions.*

2. Tariff reductions on aluminum products would provide general support for additional processing in LDCs, possibly Brazil and Indonesia. Aluminum tariffs in the United States average about 4% to 6% ad valorem, with effective protection of about 6% to 11.5%. Only 11% of U.S. imports of aluminum products originate in LDCs, and over 80% of these are subject to tariffs and the remaining 20% enter duty free under the GSP. Nearly half of the world's bauxite supplies are mined in LDCs, yet these countries produce only 19% of the world's alumina and produce and consume just over 7% of the world's aluminum. Thus, the LDCs have the opportunity to expand their capacity in alumina and aluminum production significantly if they can increase their exports to DCs.

3. Reduced DC tariffs on steel would provide little, if any, support for steel production in LDCs. To compete with DC steel producers in world markets, steel production in many LDCs needs to become more cost-effective and to be improved in terms of quality.

- Impacts of the Generalized System of Preference

4. Expansion of the U.S. GSP coverage on copper imports through relaxation of the competitive need criteria, would give LDC copper products a competitive advantage over those exported from other DCs. There is little likelihood that the competitive need criteria will be relaxed for copper because of other actions under consideration to limit imports.

5. GSP coverage of LDC aluminum exports to the U.S. does not provide much help because only 21% of the value of aluminum product imports is covered.

6. The GSP probably does not stimulate the processing of iron ore in LDCs as, for example, only 9% by value of U.S. iron and steel imports is covered under the GSP.

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*Economist, "Zambia's Copper: Strangulation," September 2, 1978, p. 99.

- Impacts of Nontariff Barriers

  7. Reference pricing on steel imports to trigger antidumping tariffs will serve to restrict entry of foreign steel priced below the reference price. At this time, it is not clear that this does provide a disincentive to LDC processing for export because of their noncompetitive position.

  8. U.S. quotas on certain specialty steel imports under the National Security Amendment do restrict the market for selected LDCs--Brazil, Argentina, and Korea; however, these countries account for a small share of U.S. steel imports and are not greatly affected by the quotas.

  9. There is the possibility of restrictions on U.S. imports of basic copper shapes to provide further protection to the domestic industry. This added protection, if provided, would lead to further disincentives to forward processing of copper in LDCs.

  10. U.S. export restrictions on scrap steel, effective in 1973-1974, provided a disincentive for LDC steel manufacturers to build low-cost facilities dependent on imported scrap to meet domestic or foreign demand. U.S. assurances that future export restrictions will be avoided could help to remove any disincentive that remains.

- Impacts of Risk Insurance Policies

  11. OPIC policies to provide more attractive risk insurance and to place added emphasis on mineral projects may result in new or expanded facilities to process bauxite, alumina, or iron ore through direct private investment or loans by U.S. companies. However, it is not clear that risk insurance alone is sufficient to encourage more multinational corporate investment in LDCs. Restrictions on OPIC coverage of copper investment projects, at least until 1981, effectively preclude support of that mineral which is most amenable to processing at or near the source of the ore supply.

- Impacts of Tax Policies

  12. Increased U.S. personal income tax burdens on persons working abroad will serve to increase the cost and reduce the supply of U.S. nationals working in LDCs.

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