Industry & Trade Summary

Copper

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PREFACE

In 1991 the United States International Trade Commission initiated its current *Industry and Trade Summary* series of informational reports on the thousands of products imported into and exported from the United States. Each summary addresses a different commodity/industry area and contains information on product uses, U.S. and foreign producers, and customs treatment. Also included is an analysis of the basic factors affecting trends in consumption, production, and trade of the commodity, as well as those bearing on the competitiveness of U.S. industries in domestic and foreign markets.[1]

This report on copper covers the period 1986 through 1991 and represents one of approximately 250-300 individual reports to be produced in this series during the first half of the 1990s. Listed below are the individual summary reports published to date on the minerals and metals sector.

USITC publication number	*Publication date*	*Title*
2475 (MM-1)	August 1992	Fluorspar and certain other mineral substances
2504 (MM-2)	November 1992	Ceramic floor and wall tiles
2587 (MM-3)	January 1993	Heavy structural steel shapes
2623 (MM-4)	April 1993	Copper

[1] The information and analysis in this report are for the purpose of this report only. Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under statutory authority covering the same or similar subject matter.

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INTRODUCTION

Copper ranks behind only iron and aluminum as the world's most widely consumed metal. Copper's attributes of malleability, ductility, good electrical and thermal conductivity, and resistance to corrosion have made it an essential material in industrial society. The United States is a major producer and consumer of copper and copper alloys.

This summary covers the copper industry for the years 1986-91.[1] During the economic recession of the early 1980s, world copper consumption declined, forcing the high-cost U.S. copper industry to contract and allowing U.S. copper imports to increase significantly. By 1986, however, substantial industry restructuring, such as the closure of high-cost operations and the adoption of more efficient production methods, coupled with a declining U.S. dollar, improved the competitiveness of the copper industry. Aided by relatively strong copper prices and a continuing modernization effort, the U.S. industry has since been able to increase production, reduce the share of the U.S. market supplied by imports, and successfully develop a larger foreign market for most copper products.

The products in this summary are separated into two main categories: unwrought (i.e., unworked) copper, which includes copper and copper alloy metals and associated copper-containing raw materials; and wrought (i.e., worked by mechanical processes) copper, which includes all semifabricated forms of copper and copper alloys and certain fabricated products.

UNWROUGHT COPPER

Product Coverage and Manufacturing Processes

Unwrought copper products are classified in chapters 26 and 74 of the Harmonized Tariff Schedule of the United States (HTS). Appendix A contains a list of tariff and trade agreement terms. Statistical tables are presented in Appendix B. Table B-1 lists the sixteen 8-digit HTS subheadings that cover unwrought copper products along with a short description.

The principal unwrought copper product is refined copper, usually in the form of a cathode, which may be produced by either a conventional process or a leaching process. A flowchart showing the steps used in producing unwrought copper is presented in figure 1. In the conventional process copper ore[2] is transformed into copper concentrates. In this process copper ore is crushed and ground into fine particles and the copper-containing minerals are physically separated from the waste minerals by flotation. (Appendix C contains a glossary of technical terms.) Copper concentrates are then treated by pyrometallurgical processes, including smelting, converting,[3] and fire refining, which produce copper mattes, blister copper, and copper anodes, respectively.[4] Anodes are cast shapes prepared for electrolytic refining, which produces copper cathodes (99.99 percent copper) and completes the conventional refined copper production process.

Low-grade ores that cannot be concentrated economically are exploited by leaching. Typically, material at open-pit mines that is removed to expose the high-grade ores contains low-grade sulfide and oxide ores that are transferred to dump areas near the mine. A leach solution is passed through the low-grade material, dissolving the copper, which is either precipitated out as a solid material called cement copper and sent to the smelter or is upgraded chemically by a process called solvent extraction (SX), followed by electrowining (EW), which produces copper cathodes.

Copper cathodes are melted in a furnace and are cast into shapes to prepare for further fabrication. These shapes include wire bars (shaped for wire making), billets, and cakes. Other metals are added to molten copper to make copper alloys. The most common copper alloy is brass, which contains zinc as the main alloying metal. Other copper alloys include bronze (usually a copper-tin alloy), copper-nickel, copper-nickel-zinc (also referred to as nickel-silver), and beryllium copper.

The metallurgical process of manufacturing copper alloys may require the use of master alloys, which are copper alloys with a large share of alloy metal. Generally, producers add master alloys to the molten copper instead of adding the alloying metal directly, to reduce the probability of a violent reaction or because the alloying metal will not dissolve and distribute readily.[5]

Recycled copper waste and scrap is another major source of copper and copper alloys. Old waste and scrap from obsolete and wornout articles and new waste and scrap from punchings and turnings generated during fabrication may be processed into refined copper at smelters and refineries or may be used directly to make copper and copper alloy shapes. There are typically no quality differences between primary (i.e., produced from ores) and secondary (i.e., produced from recycled materials) copper and copper alloys.

In the conventional refined copper production process, byproducts containing valuable metals such as

[1] Certain 1992 trade data have also been included in some sections.

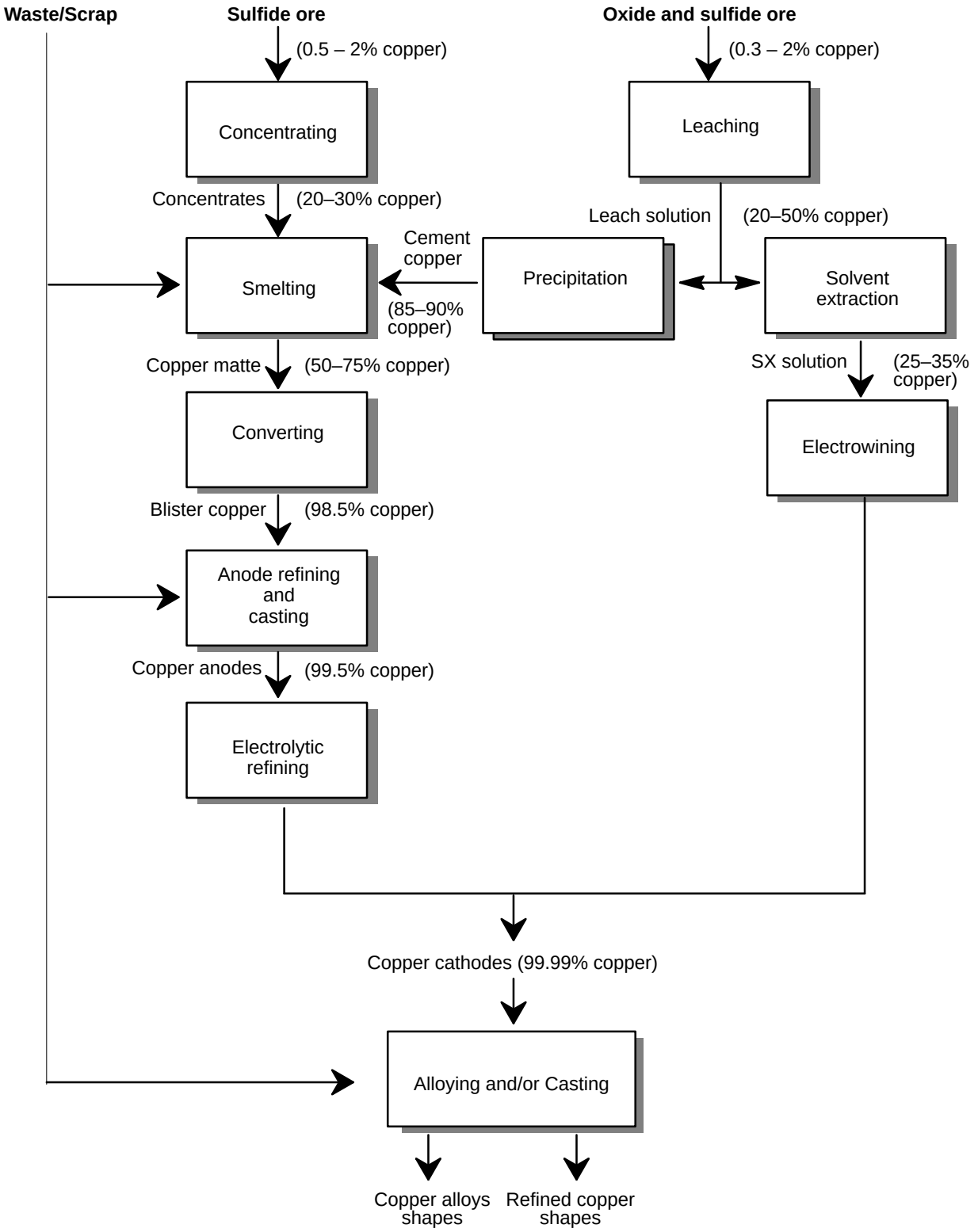
[2] Copper ores are a collection of copper-containing minerals and waste minerals. Most of the copper produced in the world comes from sulfide minerals (i.e., sulfur is the main nonmetallic element that is chemically bonded to the copper atom).

[3] Smelting and converting are done at a smelter and are typically referred to collectively as smelting.

[4] Copper concentrates and mattes may also be recovered as a byproduct from processing other metal ores and are generally sold to copper smelters for further processing.

[5] The principal master alloys are phosphor-copper, manganese-copper, and beryllium-copper.

Figure 1
Unwrought copper: Production flowchart



Source: Office of Technology Assessment.

gold, silver, lead, zinc, and molybdenum may be produced and are typically collected at the concentrating stage or at the electrolytic refining stage. The copper producer may process these byproducts to recover the pure metal or may sell them to other processors. Typically, byproducts are considered as credits and essentially reduce the production costs of copper. Another significant byproduct formed during smelting is sulfur gas, which is usually processed into sulfuric acid that may be used in the producer's leaching operations or may be sold on the open market.[6]

Principal End Uses

Unwrought copper products are consumed by the wrought copper industry and certain miscellaneous industries (chemical, steel, aluminum, and other industries). The following tabulation shows the percentage of copper consumed by each wrought copper sector (including the copper content of directly consumed waste and scrap) in the United States as reported by the Copper Development Association:

Wrought copper sector	Product(s)	Percent of copper consumption
Wire mills	Copper wire	54
Brass mills	Copper and alloy shapes, flat products, tubes and pipes, alloy wire.	35
Foundries	Copper and alloy castings.	7
Powder mills	Copper and alloy powders and flakes.	1
Miscellaneous industries	Other metal alloys, chemicals.	3

U.S. Industry Profile

The prolonged depressed price of copper during 1982-86 initiated major structural changes in the U.S. copper industry, especially the primary unwrought sector. Large investments in more efficient plant and equipment, revisions in labor agreements, employment reductions and productivity improvements, and changes in ownership dramatically reshaped the industry. These structural changes lowered production costs and helped to significantly improve the competitiveness of the U.S. copper industry in both domestic and foreign markets.

[6] Environmental regulations usually limit sulfur gas emissions. Such measures force smelters to recover the gas and convert it to acid.

Industry Structure

The principal raw materials, producer types, major products, and end users for the U.S. unwrought copper industry are shown in figure 2.[7] Primary copper smelters and refineries consume concentrates, mattes, and cement copper; electrowining plants consume leach solutions; and secondary copper smelters and refineries consume waste, scrap, ashes, and residues. The unwrought copper industry sells cathodes primarily but also sells other shapes made from cathodes, such as wire rod, billets, or cakes. Ingot makers consume primarily alloy waste and scrap to produce copper alloy ingots and typically sell their products to foundries.

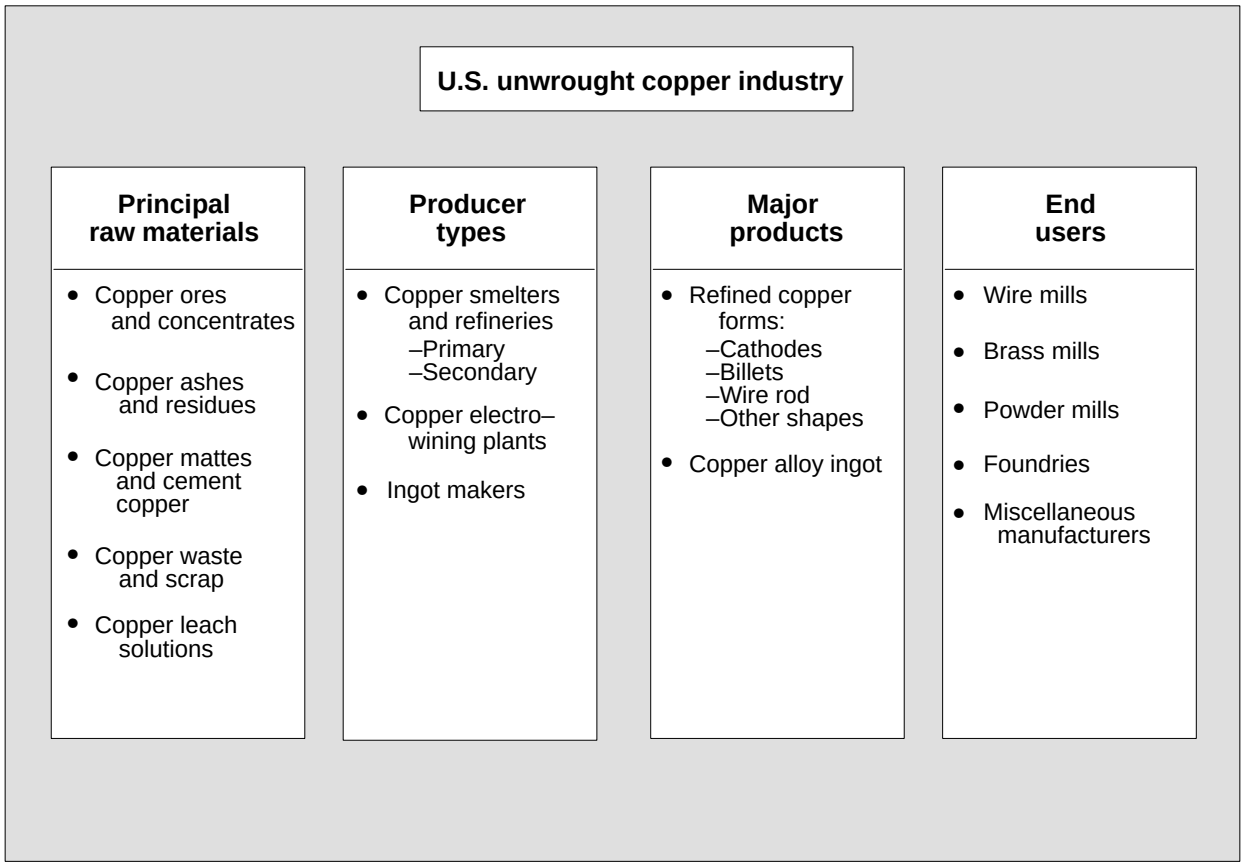
The U.S. unwrought copper industry is the world's largest producer. Employment and capacities of the industry have increased moderately during 1986-91 because of increasing copper consumption (table 1). The U.S. primary unwrought copper industry is dominated by 5 vertically integrated producers, which account for over 90 percent of U.S. primary refined copper production—Phelps Dodge Corp., the largest producer; Magma Copper Co.; ASARCO Inc.; Kennecott Corp.; and Cyprus Minerals Co. These producers operate mines, concentrators, smelters, refineries, and electrowining plants, most of which are in Arizona, New Mexico, Utah, and Texas. Of the 62 copper-producing mines operating in 1990, 36 were copper mines and 26 were other mines where copper was recovered as a byproduct. The top 10 copper mines accounted for over 90 percent of production. Open-pit mines account for approximately 80 percent of production; the balance is from underground mines. Arizona accounted for about 60 percent of the mined copper and along with New Mexico and Utah accounted for over 90 percent of U.S. production of mined copper. Other states where copper is mined include Michigan, Montana, and Missouri.

The U.S. secondary unwrought copper industry is dominated by three producers: Southwire Co., Gaston Copper Recycling Corp. (80 percent owned by Southwire), and Cerro Copper Co. These producers buy scrap on the open market and use scrap generated in their downstream operations. These firms are primarily in Georgia, South Carolina, and Illinois.

Copper waste and scrap constitutes a large and important U.S. industry by itself. The United States is the world's largest generator and exporter of copper waste and scrap. Copper waste and scrap is generated at thousands of points throughout the industrial infrastructure and end-use markets. Numerous scrap dealers act as centralized points in the collection of waste and scrap. These dealers sell scrap to the secondary smelters and ingot makers.

[7] Unwrought copper products are included in the following Standard Industrial Classification (SIC) categories: SIC 1021, Copper Ores; SIC 3331, Primary Smelting and Refining of Copper; and part of SIC 3341, Secondary Smelting and Refining of Nonferrous Metals.

Figure 2
U.S. unwrought copper industry: Principal raw materials, producer types, major products, and end users



Source: Compiled by the staff of the U.S. International Trade Commission.

Ownership and Integration

Horizontal integration is an important strategy of both U.S. and foreign copper companies. It ensures that earnings are not dependent on a single commodity. ASARCO operates lead, zinc, and silver mines and lead smelters and refineries in the United States. Cyprus is the world's largest producer of molybdenum and lithium and also produces coal and gold. Phelps Dodge has some gold mining operations.

At the beginning of the 1980s, much of the U.S. unwrought copper industry was integrated with the oil industry. During the late 1970s, oil companies used the profits generated by high oil prices to acquire copper-producing companies. The copper business was seen as an extension of their natural-resource-oriented businesses. SOHIO owned Kennecott, Amoco owned Cyprus, and Atlantic Richfield owned Anaconda. Occidental, Pennzoil, and Louisiana Land and Exploration Co. also owned copper mines. However, with low copper prices in the 1980s, oil companies generally regarded their copper operations as underperforming assets, and the copper acquisitions were divested. All of these oil companies exited the copper industry during the 1980s, and Anaconda no longer is producing copper. Kennecott sold two of its three major mines to ASARCO and Phelps Dodge and Amoco spun Cyprus off as an independent company. Although it was anticipated that oil companies, with their large capital spending capabilities, would be able to modernize the U.S. copper industry, they did not do so, and with divestiture the oil companies ended up contributing little to the copper industry.[8] Copper-producing companies are now independent firms or a division of a mining company. Copper companies in foreign countries are typically owned by firms with other large mining operations or by state-controlled companies that produce mostly copper and copper byproducts.

[8] Kenji Takeuchi and others, *The World Copper Industry: Its Changing Structure and Future Prospects*, World Bank Staff Commodity Working Papers, No. 15 (Washington, DC, 1987), p. 145. The exception to this is SOHIO's mine and mill modernization of Kennecott's Bingham Canyon mine.

Table 1
Unwrought copper: Establishments, employment, and capacities, 1986-91

Item	1986	1987	1988	1989	1990	1991
			Number of establishments			
Mines	87	52	65	68	62	(1)
Smelters:						
Primary	9	9	8	9	8	8
Secondary	7	5	5	5	5	5
Refineries:						
Primary:						
Electrolytic..	7	7	8	8	8	8
Electrowining	10	10	11	12	14	14
Secondary	10	9	9	8	8	8
Total	130	92	106	110	105	(1)
			Employment *(thousands)*			
Mines and concentrators[2]	10.2	11.9	11.9	12.4	13.0	13.0
Smelters and refineries:						
Primary	3.9	3.3	3.6	3.8	(1)	(1)
Secondary[3]	1.5	1.5	1.5	1.5	1.5	1.5
Total	15.6	16.7	17.0	17.7	(1)	(1)
			Capacities *(1,000 mt of copper content)*			
Mines	1,430	1,520	1,620	1,790	1,860	(1)
Smelters:						
Primary	1,100	1,156	1,296	1,391	1,370	(1)
Secondary	208	282	395	416	420	(1)
Refineries:						
Primary	(1)	1,980	2,202	1,810	(1)	(1)
Secondary	(1)	(4)	(4)	636	(1)	(1)

[1] Not available.

[2] Includes employment at electrowining plants.

[3] Estimated by staff of U.S. International Trade Commission from U.S. Bureau of Census data for 1987.

[4] Included in primary refinery capacity.

Note.—Each mine typically has an associated concentrator.

Source: U.S. Bureau of Mines, except as noted.

Vertical integration is also an important strategy of copper companies to ensure a steady supply of feed material for their downstream operations. The major U.S. primary copper companies are vertically integrated within the unwrought sector (i.e., mining through refining), but integration between the unwrought and wrought copper sectors has declined markedly over the last 10 to 15 years. Wrought copper products are mostly low-margin items, and the unwrought companies sold off their wrought copper facilities to focus resources on unwrought production. The significant exception is the production of wire rod,[9] in which about 50 percent of U.S. capacity is owned by the primary unwrought producers. The other 50 percent of capacity is owned mostly by wiremaking companies, two of which are integrated upstream by owning large secondary smelters and refineries. Most of the European and Japanese unwrought copper companies are dependent on foreign sources for feed material. The European companies must import concentrate and unrefined copper to feed their smelting and refining plants. Japanese firms have smelting, refining, and wrought production facilities but, because of a lack of copper deposits in Japan, have virtually no mining facilities and must import the bulk of their concentrate requirements. Copper producers in developing countries may have some wrought copper facilities, but the large majority of their sales are of unwrought products.

[9] Wire rod is a wrought copper product and is the feed for making wire.

Globalization

The unwrought copper industry has historically had a global orientation, with unwrought products, production technology, and foreign investment moving freely across country borders. As deposits were depleted in the industrialized countries, companies began expanding internationally in search of deposits in the less developed countries, where copper

industries were formed as early as the late 19th century. Western European and Japanese companies invested in African and Asian countries to develop supply sources for their copper smelting and refining industries. U.S. companies made large investments in Latin American countries to supply the U.S. market. Kennecott, Anaconda, and Cerro Copper Co. made large investments in Chile and developed the country as a major copper producer.[10]

Both U.S. companies and companies based in other countries are prominently involved in foreign operations. An important aspect of unwrought copper projects is the joint venture arrangement. Because the investment requirements and risk are often high, companies seek partners in unwrought copper operations. Typically, U.S. companies pursue investments abroad because of declining ore grades and the prospect of increasingly stringent environmental regulations in the United States. Examples include the following:

- ASARCO owns a majority share of Southern Peru Copper Corp. (SPCC), which operates copper mines, smelters, and refineries in Peru. Phelps Dodge, Newmont Mining Co., and Cerro Copper Co. own the rest of SPCC;
- ASARCO owns 31 percent of Mexico Desarrollo Industrial Minero, Mexico's largest mining company and operator of Mexico's two major copper mining complexes;
- ASARCO owns a minority equity position in Australian MIM Holdings Limited, which operates copper, silver, lead, zinc, gold, and coal mines and processing plants in Australia and Papua New Guinea;
- Phelps Dodge owns the Chilean company Compania Minera Ojos del Salado, which operates a small mine complex, but is planning to develop the La Candelaria copper deposit with an investment of over $500 million (Sumitomo of Japan will provide 20 percent of the investment);
- Exxon owns the Chilean company Compania Minera Disputada de las Condes, which operates two mine complexes and a smelter. The Disputada copper mine is presently being expanded, and the company is also planning a major investment to increase smelter capacity;
- Chevron is a partner in the Collahuasi project, a joint venture with two other companies in Chile.[11] A preliminary assessment envisions an investment of $1 billion to develop a large copper mine by the late 1990s;
- Freeport-McMoRan owns 85 percent of the Ertsberg copper mine in Indonesia.

Foreign investment in the U.S. industry has been enhanced by the declining value of the dollar since 1985, thus making U.S. copper assets relatively inexpensive. Such investment has been a key source of modernization funding. About 25 percent of mine production and 20 percent of refined copper production is owned or controlled by foreign companies. The most prominent foreign interests include—

- Kennecott Corp. is owned by RTZ, Inc., a major international natural resources company based in Britain;
- Two of Phelps Dodge's mines are joint ventures with Japanese companies. These companies take their share of the venture's return in the form of concentrates that are shipped to smelters in Japan;
- The White Pine copper mine, smelter, and refinery in Michigan is owned by a Canadian company that is a subsidiary of Metallgesellschaft AG of Germany;
- MIM of Australia owns a minority equity position in ASARCO;
- Mitsubishi Corp. of Japan owns 80 percent of the Cox Creek refinery.
- Gaston Copper Recycling Corp. is partially owned by Boliden (Sweden), Trelleborg (Sweden), and Mitsubishi.

Pricing and transactions

The most important factor affecting the economic viability of an unwrought copper producer is the price of copper. Because of arbitrage, there is essentially a single world price for copper. Transportation costs and tariffs in most countries are relatively minor. The price of copper fluctuates considerably in response to variations in supply and demand (figure 3). Such fluctuation is a significant consideration for refined copper producers, since production costs cannot vary much in the short run. For example, during 1988 the average monthly price varied from $0.65 per pound to over $1.30 per pound. During 1984-86 the price was the lowest in real terms since the Depression, prompting structural changes by the industry. Copper stocks tend to increase as prices decrease because producers are hesitant to reduce production because of high fixed costs. After 1986 the price of copper began to increase substantially in response to strong worldwide economic expansion. In 1989 significant production problems in many foreign countries pushed the price of copper over $1.50 per pound for a short time.[12]

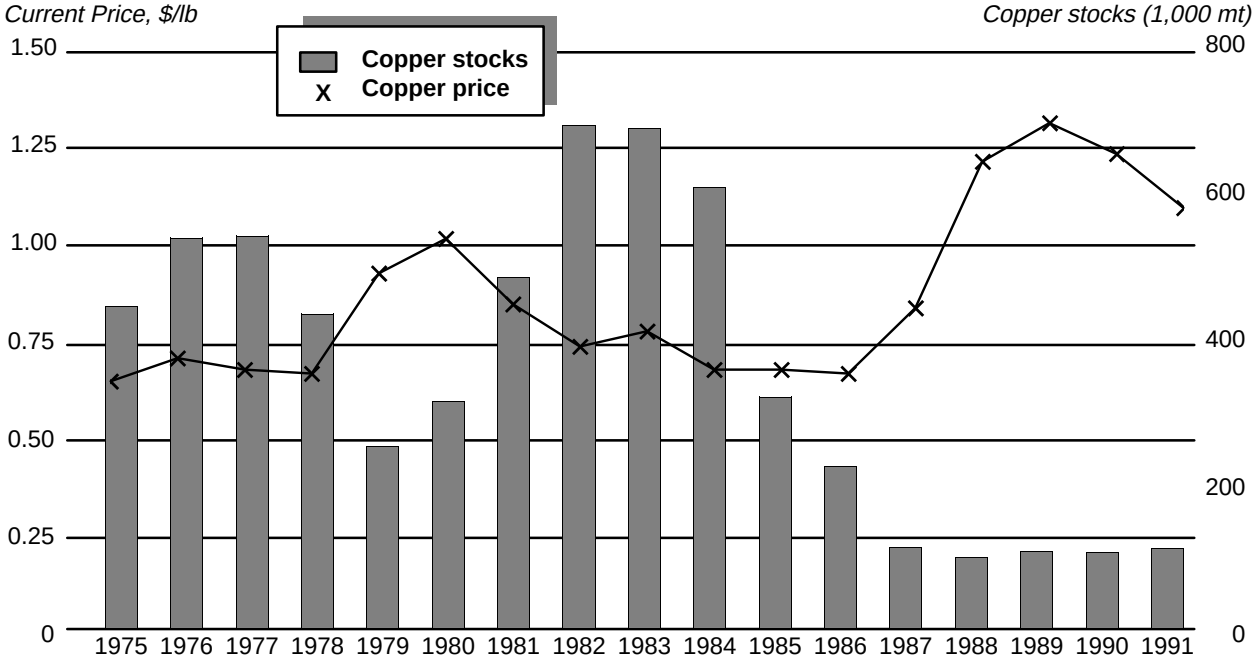
Free-market prices for copper are quoted on two major commodity exchanges: the London Metal

[10] Chile fully nationalized its copper industry in 1971 and expropriated these U.S. operations.

[11] Chevron recently announced intentions to divest their share of the Collahuasi project.

[12] Standard practice in the U.S. market is to quote price in terms of English units of measure.

Figure 3
Unwrought copper: U.S. producer price and U.S. copper stocks, 1975-91



Source: U.S. Bureau of Mines.

Exchange (LME) and the New York Commodity Exchange (COMEX). Standard copper grades and shapes are bought and sold on a competitive basis, with prices changing continuously. The most important price quoted is for copper cathode. Prices on the two exchanges tend to move together. Most copper producers in the United States maintain a producer price, which includes a slight premium for delivery costs. This price tracks the COMEX exchange price. Transaction prices outside the United States and involving imports into the United States track the LME price.

Prices for other unwrought copper products are calculated as a function of one of the exchange prices. For example, the price for concentrates is calculated by taking an exchange price, subtracting treatment charges, adding byproduct credits, and subtracting transportation charges.

Only a small portion of copper transactions, estimated at 5 to 20 percent, go through the commodity exchanges. Most transactions are direct contracts between copper producers and semifabricators. Contracts for refined copper are usually for 1 year and specify a price based on the exchange price at time of delivery.

Traders are also active in the copper market. They buy copper directly from producers or on the exchanges and sell to semifabricators or other traders. Typically, traders help to meet short-term demand changes and operate with odd-lot or other special circumstances transactions or act as an agent for a producer.

Copper is considered a critical material and is part of the National Strategic Stockpile. Stockpile transactions can affect the price of commodities, although they have not done so for copper since the early 1960s. Currently, the official goal is 1 million short tons, but the existing stockpile is only a small fraction of this. The stockpile program is currently being reviewed, and goals may be substantially reduced in the future.

Costs

Since most unwrought copper products are fungible items, making it difficult to differentiate products, the most important determinant of producer competitiveness is the cost of production. The U.S. unwrought copper industry underwent extensive structural changes during the 1980s, largely in response to low copper prices. Mining costs declined significantly because high-cost operations were closed down; new, cost-efficient conveyor haulage systems were installed; pit slopes were steepened; and use of the low-cost leaching production method was expanded. Producers lowered smelting and refining costs by closing plants using old technology and by modernizing the remaining plants. As a result, the U.S. industry lowered production costs by 33 percent during 1981-90 and substantially reduced costs as compared with other world producers (table 2).

The U.S. industry is evaluating new production and processing methods that could further decrease costs.

Table 2
Average U.S. refined copper production costs, 1981 and 1987-90

(Current dollars per pound copper)

	1981	1987	1988	1989	1990
United States:					
Mining	0.33	0.19	0.18	0.17	0.17
Concentrating	0.28	0.29	0.28	0.28	0.27
Smelting and refining	0.35	0.15	0.17	0.18	0.18
Less byproduct credits	0.17	0.11	0.10	0.11	0.10
Total	0.79	0.52	0.52	0.52	0.53
World average	0.62	0.45	0.47	0.51	0.57
U.S. total cost as percent of world average	127	116	111	102	93

Note.—Because of rounding, figures may not add to totals shown. Depreciation and taxes not included. Shipping costs included in smelting/refining costs. Comparable 1982-86 and 1991 data are not available.

Source: U.S. Bureau of Mines.

For example, the industry is conducting research and development in cooperation with the U.S. Bureau of Mines to evaluate the feasibility of producing copper through an in situ leaching process (i.e., the ore would not be moved). This process could lower mining costs.

Investment

Large modernization investments have been a major part of the unwrought copper industry efforts to cut costs. Table 3 lists some of the more recent investments. As a result, the U.S. industry is relatively modern, especially compared with the major producers in less developed countries. These producers are generally state owned and have suffered some neglect because of other priorities of these governments.

Total investment costs can exceed $1 billion for a new, large, conventional copper mining and processing complex. The remoteness of many producing areas adds to the costs. These investment costs include exploration; mine development (preproduction costs); mine equipment (trucks, conveyor systems); concentration plant (crushers, grinders, flotation equipment); smelter; refinery; infrastructure installations (road, railway, port facilities, energy, and water supply); and auxiliary facilities (housing, recreational areas, schools, hospitals, training facilities, etc.). Additional expenditures that must be considered include acquisition costs, concession fees, feasibility and planning costs, interest during construction, and environmental compliance costs. For example, the investment required for the recently opened La Escondida mine and concentrator and ancillary items in Chile was about $850 million, which does not include the cost of a smelter or refinery plant.

Investment costs for a new SX-EW plant are much less than for a conventional operation. The Bureau of Mines reports that capital costs for new SX-EW plants average $2,400 per ton of capacity, compared with $8,100 per ton for new conventional mine capacity and $3,200 per ton for expansion of capacity at an existing conventional mine.[13] SX-EW investment requirements are low because leachable waste dumps already exist at copper mining sites, thus requiring only the construction of facilities for distributing and collecting leach solutions and a processing plant.

Employment and productivity

Large investments in new, more labor-efficient plants and equipment, especially in the less labor-intensive SX-EW method of producing copper, have reduced employment and have increased productivity substantially in the U.S. copper industry. Employment has decreased significantly since 1981, when over 30,000 people were employed by copper mines and concentrators, compared with approximately 13,000 people in 1990, even though production in both years was about the same. According to the U.S. Bureau of Mines, overall productivity for the copper industry (including mining, concentrating, smelting, and refining), increased by over 40 percent from 1985 to 1990.

Also contributing to increased productivity has been the restructuring of labor agreements and in some cases the discontinuation of union representation. Reportedly, this trend has greatly relaxed work rules and has helped slow escalating wage rates. According to the U.S. Department of Commerce's Census of Mineral Industries, wage rates in copper mines were $8.09 per hour in 1977, $14.47 per hour in 1982, and $13.53 per hour in 1987.

Environmental considerations

Environmental regulations are also a major competitive factor in the unwrought copper industry, because the cost of compliance reportedly adds a greater burden to U.S. producers than to many foreign producers (mostly in the less developed countries). The primary industry generates a tremendous amount of waste products and uses a large amount of water. In the

[13] To be comparable, the investment costs of smelting and refining should also be added to the capital costs required for the conventional process.

Table 3
Unwrought copper: Modernization investments

Company	Project	Startup date	Investment amount
			Million dollars
Kennecott	New concentrator and in-pit crushing and conveying system at Bingham Canyon mine	1988	400
Phelps Dodge	New SX-EW plant at Chino mine	1988	55
Magma	Modernization and expansion of San Manuel smelter.	1988	277
Phelps Dodge	In-pit crushing and conveying system at Morenci mine.	1989	48
Phelps Dodge	Expansion of SX-EW plants at Morenci and Tyronne mines.	1989	65
ASARCO	Mission mine expansion.	1991	100
Cyprus	Modernization and expansion of Miami smelter	1992	93
ASARCO	New concentrator and in-pit crushing and conveying at Ray mine.	1992	194
ASARCO	El Paso smelter modernization	1993	81
ASARCO	SX-EW plant at Silver Bell mine	1994	54
Kennecott	New smelter and refinery expansion at Utah operations.	1995	880

Source: U.S. Bureau of Mines.

United States numerous Federal and State regulations apply to the industry, including the Clean Water Act, the Clean Air Act, the National Environmental Policy Act (which requires the preparation of environmental impact statements), the Solid Waste Disposal Act (also known as the Resource Conservation and Recovery Act), the Surface Mining Control and Reclamation Act, the Toxic Substances Control Act, and the Comprehensive Environmental Response Compensation and Liability Act of 1980. These regulations add significant capital and operating costs to the industry. Total capital costs for air pollution control are estimated at about $2.5 billion (1981 dollars) for the 1970-90 period.[14] Total operating costs were over $6 billion (1981 dollars) during this period. Present capital and operating costs for pollution compliance are estimated at $0.10 to 0.15 per pound of copper, which is 9 to 14 percent of the 1991 average U.S. producer price. Seven U.S. copper smelters, representing 36 percent of capacity, shut down during 1975-87, and some of these closures have been attributed to the high cost of complying with emission regulations.[15]

Developing countries, however, have become more aware and sensitive to the damage caused by their mining industries and have begun to implement more stringent environmental regulations. For example, Chile passed a new law in January 1992 designed to limit the discharge of sulfur gas. This trend suggests that the U.S. industry's cost disadvantage caused by environmental compliance regulations may decline in the future.

[14] Capital and operating cost from U.S. Congress, Office of Technology Assessment, *Copper: Technology and Competitiveness*, OTA-E-367 (Washington, DC: GPO, Sept. 1988), p. 241.

[15] This loss of smelting capacity has been offset by the growth in the SX-EW method of producing copper.

U.S. Trade Measures

Tariff and Nontariff Measures

U.S. tariffs for unwrought copper products are among the lowest in the world. The column 1 tariff rates applicable to almost all unwrought copper products are 1 percent or less (table B-1). The trade-weighted average tariff rate in 1991 was 0.4 percent for these products. Duties on eligible imports from Canada shown on table B-1 represent the 4th year of staged reductions under the U.S.-Canada Free-Trade Agreement (CFTA). As of January 1, 1993, these duties have been completely phased out. All products are eligible for duty-free treatment under the Generalized System of Preferences (GSP), the U.S.-Israel Free Trade Agreement (IFTA), the Caribbean Basin Economic Recovery Act (CBERA), and the Andean Trade Preference Act (ATPA).[16] Two important U.S. market suppliers—Mexico and Chile—have been suspended from GSP eligibility for certain unwrought copper products because they exceeded competitive-need limits. Mexico has been suspended from GSP treatment for copper ores and concentrates (HTS subheading 2603.00.00), copper mattes (HTS subheading 7401.10.00), and unrefined copper (HTS subheading 7402.00.00). Chile has been suspended from GSP treatment for unrefined copper and all unwrought copper and copper alloys (HTS subheadings 7403.11.00 through 7403.29.00). Under the proposed North American Free Trade Agreement (NAFTA), all U.S. duties on imports of unwrought copper products from Mexico would be eliminated as of January 1, 1994.

There are no explicit nontariff measures that affect trade or investment in the U.S. copper industry. However, industry representatives from other countries

[16] The Andean Trade Preference Act became effective in July 1992.

claim that the availability of low-interest loans for pollution abatement and U.S. Bureau of Mines research and development constitute subsidies to the domestic minerals and metals industries.

U.S. Government Trade-Related Investigations

In 1984 the domestic unwrought copper producers filed with the U.S. International Trade Commission (ITC) a petition for import relief under section 201 of the Trade Act of 1974. The ITC made an affirmative injury determination and recommended to the President that import relief in the form of higher duties or quantitative restrictions be imposed on certain unwrought copper products.[17] However, the President determined that it was not in the national economic interest to provide relief, since it would disadvantage the U.S. copper-fabricating industry.[18]

U.S. Market

Consumption

The intensive modernization efforts by the U.S. unwrought copper producers contributed to a strong improvement in their competitive position in the U.S. market. Refined copper imports as a share of consumption dropped from 24 percent in 1986 to 14 percent in 1991 (table 4 and figure 4). During this period, the price of refined copper increased substantially, from below $0.70 per pound in 1986 to $1.10 to 1.30 per pound during 1988-91. This increase also contributed to the recovery of the U.S. industry. Consumption of unwrought copper in the United States increased substantially during 1986-89 as a result of strong U.S. industrial expansion and declined moderately during 1990-91 because of a weakening economy.

Most unwrought copper products are internationally traded, fungible items, and quality differences between domestic and foreign products are minimal. Since product differentiation is not possible, producers strive to minimize costs to remain competitive. Foreign copper producers generally enjoy higher grade copper deposits, lower labor costs, lower environmental compliance costs, and higher byproduct credits than U.S. copper producers do. However, the U.S. industry has countered these foreign advantages to a large extent by modernizing aggressively and by expanding the low-cost leaching method of copper production.

Production

An important part of the increasing competitiveness of the U.S. industry has been the expansion of the leaching method of producing copper. Production costs for this method are reportedly about $0.40 per pound (compared with the industry average of about $0.60 per pound) and its portion of mined copper production has increased significantly, from 12 percent in 1986 to 25 percent in 1990 (table 5). Production of mined copper, unrefined copper, and refined copper increased by 43 percent, 21 percent, and 35 percent, respectively, during this period.

Imports

The restructured U.S. copper industry has taken a larger share of the domestic market at the expense of imports. Imports from some traditional suppliers of unwrought copper to the U.S. market, such as Chile and Peru, have declined sharply.

Although table 6 shows that imports of unwrought copper products increased by 30 percent in value terms during 1986-91, imports have actually decreased in quantity terms during this period (tables B-3 through B-5).[19] Imports in 1991 of refined copper (the most important unwrought copper import) by quantity were less than 60 percent of the import level in 1986.

In 1992, imports of unwrought copper products were $1.2 billion, an increase of about 8 percent from 1991. However, refined copper imports by quantity increased by less than 1 percent in 1992.

[17] U.S. International Trade Commission, *Unwrought Copper* (Investigation No. TA-201-52), USITC publication 1549, July 1984.

[18] President, memorandum of Sept. 6, 1984, "Copper Import Relief Determination," 49 FR 35609 (Sept. 11, 1984), microfiche.

[19] This situation is caused by the varying price of copper.

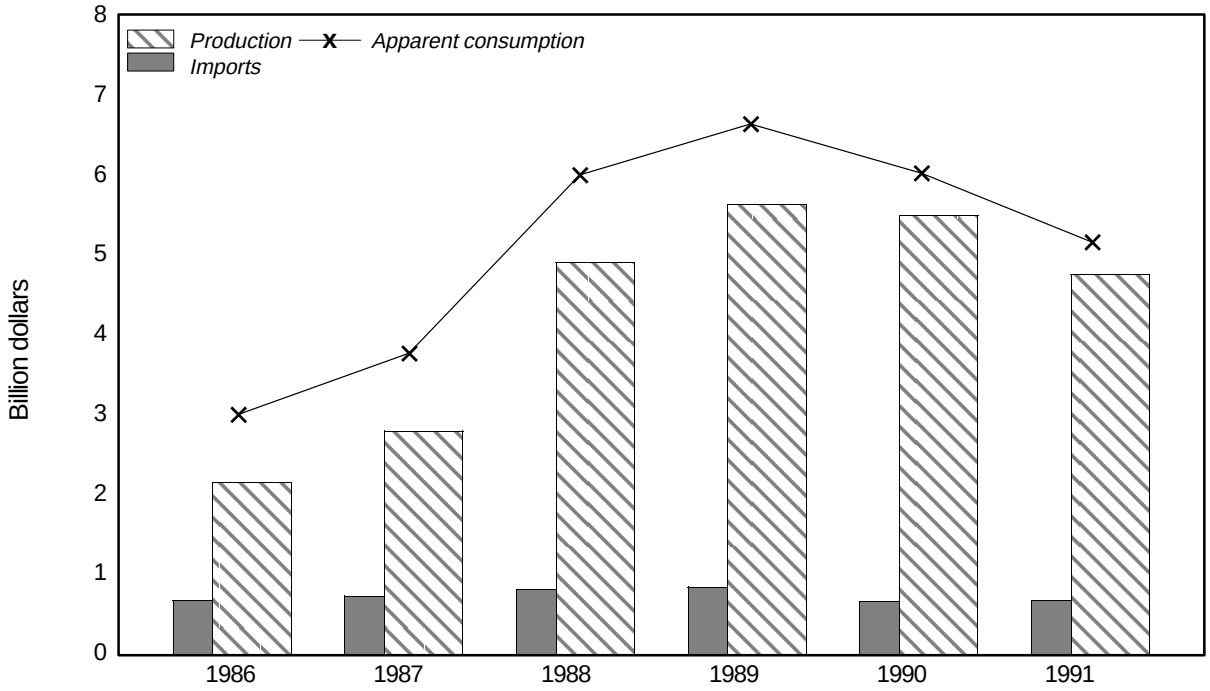
Table 4
Refined copper: U.S. production, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1986-91

Year	U.S. production[1]	U.S. exports	U.S. imports	Apparent U.S. consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1986	2,155	18	677	2,814	24
1987	2,805	19	735	3,521	21
1988	4,918	138	813	5,593	15
1989	5,641	303	847	6,185	14
1990	5,505	555	666	5,616	12
1991	4,760	624	675	4,811	14

[1] Estimated by the staff of the U.S. International Trade Commission.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Figure 4
Refined copper: U.S. imports, production, and apparent consumption, 1986-91



Note.—Apparent consumption = Production + Imports - Exports.

Source: Production estimated by staff of the U.S. International Trade Commission; imports compiled from official statistics of the U.S. Department of Commerce.

Table 5
Unwrought copper: U.S. production of selected products, 1986-91

(1,000 metric tons)

Product	1986	1987	1988	1989	1990	1991
Mined copper:[1]						
Concentrated[2]	906	992	1,113	1,126	1,154	([3])
Leached[2]	135	162	228	312	393	([3])
Other[4]	103	90	76	59	40	([3])
Total	1,144	1,244	1,417	1,497	1,587	1,635
Unrefined copper:[1]						
Primary	908	972	1,043	1,120	1,158	1,086
Secondary	288	277	320	359	305	364
Total	1,196	1,249	1,363	1,479	1,463	1,450
Refined copper:						
Primary	1,074	1,127	1,406	1,477	1,577	1,583
Secondary	406	415	446	477	441	418
Total	1,480	1,542	1,852	1,954	2,018	2,001

[1] Copper content.
[2] From copper ores.
[3] Not available.
[4] From cement copper and other metal ores.

Source: U.S. Bureau of Mines

Table 6
Unwrought copper: U.S. imports for consumption, by principal sources, 1986-91

(1,000 dollars)

Source	1986	1987	1988	1989	1990	1991
Canada	342,814	427,421	567,185	650,791	658,697	600,294
Chile	245,112	208,685	299,233	340,468	183,278	181,318
Mexico	79,758	51,827	49,091	110,322	231,308	106,918
Brazil	52	0	2,353	50,911	25,715	57,217
Peru	61,050	51,817	44,531	33,289	14,940	52,928
Japan	273	6,621	85,151	79,960	17,746	45,242
Netherlands	111	12,148	13,056	9,525	1,415	15,219
Indonesia	0	0	0	0	27	7,948
Venezuela	53	396	2,424	12,357	11,529	7,130
Portugal	0	0	0	36	8,529	5,020
All other	125,768	159,066	189,108	102,317	64,603	33,929
Total	854,991	917,981	1,252,132	1,389,976	1,217,787	1,113,163

Source: Compiled from official statistics of the U.S. Department of Commerce.

Canada is the largest supplier of imports, mostly of refined copper, because its copper industry is well situated to supply U.S. unwrought copper consumers, who are concentrated near Canadian production facilities. Mexico has limited smelting and refining capacity and its exports to the United States are mostly concentrates and unrefined copper to U.S. companies in Arizona and Texas. Brazil appears as a new refined copper supplier to the U.S. market; economic contractions in Brazil have decreased domestic consumption of copper, which reportedly has been redirected to the U.S. market.

The main imports include copper concentrates, unrefined and refined copper, and copper and copper alloy waste and scrap. Compared with the world, the United States ranks as a relatively small importer of concentrates, a large importer of unrefined copper, and a modest importer of refined copper. The principal importers include primary and secondary unwrought copper producers and wrought copper companies.

Imports under GSP duty-free provisions totaled about $99 million in 1991, about 9 percent of total unwrought copper imports. The leading suppliers were Brazil and Peru, and the majority of these imports were unrefined and refined copper. There were no imports under other duty-free provisions (CBERA, IFTA) or under provisions of HTS subheadings 9802.00.60/9802.00.80 (formerly 806/807).[20]

Foreign Industry Profile

A large portion of the world's mined copper production is in developing countries, which typically have richer ore deposits than the industrialized countries. The exploitation of copper resources has been an important mechanism for economic growth in many developing countries. In many cases, the establishment of foreign copper industries has been aided by large U.S., Western European, and Japanese mining companies that often pursue investments abroad because of (1) declining deposit grades or a lack of deposits in their home markets; and (2) increasingly stringent domestic environmental regulations. Development banks have also played a role in providing funds for copper projects in developing countries, although this role has decreased in recent years, in part because of debt problems in many of these countries.

Competitiveness in producing refined copper is a function of ore grades; byproduct content of ore; physical characteristics of ore body (depth, type of ore, continuity, etc.); labor rates; energy costs; and environmental compliance costs. Generally, producers in the less developed countries (Chile, Zaire, Zambia, and the Philippines) have lower labor rates and less environmental costs than those in developed countries (the United States and Canada). Canada, the Philippines, and Zaire have high byproduct credits in their copper ores. The U.S. labor cost disadvantage is offset to some extent by a high degree of mechanization and automation. The U.S. industry's modernization effort, augmented by a decline in the value of the U.S. dollar, has successfully lowered costs relative to the world's major producers (table 7). Chile's production costs could decrease in the future, because expansion plans include a significant increase in low-cost SX-EW production.

Foreign producers have not been as aggressive as U.S. producers in modernizing and improving the technology of their operations. The industries in Chile, Zaire, Zambia, Mexico, and Peru have been dominated by state-controlled companies; these Governments often have neglected reinvestment and favored other uses for their industries' earnings. Zaire and Zambia suffer from a shortage of foreign exchange and thus have a limited ability to purchase new equipment and

[20] Imports under HTS subheading 9802.00.60 are articles of metal manufactured in the United States that are exported to be advanced in value or improved in condition by any process of manufacture and returned to the United States for further processing. Imports under HTS subheading 9802.00.80 are articles assembled abroad from components manufactured in the United States. Under both these subheadings, duties are assessed on the value-added component.

Table 7
Average refined copper production costs of major producers, 1981 and 1987–90

(Current dollars per pound refined copper)

Country	1981	1987	1988	1989	1990
United States	0.79	0.52	0.52	0.52	0.53
Australia	(1)	(1)	0.39	0.51	0.52
Canada	0.50	0.45	0.36	0.36	0.51
Chile	0.45	0.30	0.34	0.37	0.40
Mexico	0.61	0.49	(1)	(1)	(1)
Peru	0.63	0.52	0.76	0.65	0.77
Philippines	0.68	0.53	0.39	0.56	0.49
Zaire	0.50	0.45	0.45	0.37	0.65
Zambia	0.68	0.43	0.76	1.04	0.86
Other	0.58	0.51	0.57	0.53	0.71
World average	0.62	0.45	0.47	0.51	0.57

1 Included in "other" category.

Note.—Figures include mining, concentrating, smelting, refining, transportation costs and byproduct credits but do not include depreciation and taxes. Comparable 1982-86 and 1991 data are not available.

Source: U.S. Bureau of Mines.

machinery. However, many countries that produce copper have recently liberalized their mining laws to attract foreign investment to expand and modernize their copper production operations. Australia and countries in Latin America and Africa have taken steps to increase foreign investment, and some of these countries have announced plans to privatize copper-producing operations. In Chile, which has been successful in attracting foreign investment because of a relatively liberal investment climate, foreign companies are the primary developers of new production. International mining companies typically have operations that use modern and efficient mining methods and equipment, and if foreign investment does materialize in other countries that are liberalizing their investment climates, the U.S. advantage in technology may decrease.

The cost of complying with environmental regulations is an area in which there is a notable cost difference among producers. Environmental regulations in developing countries tend to be less strict or are less strictly enforced than in the United States and other industrialized countries. For example, U.S. copper smelters typically recover over 90 percent of the sulfur in the copper concentrates, whereas smelters in Chile recover well under 50 percent. However, a new Chilean law effective in January 1992 provides for stricter gas emission regulations and a large part of the planned investments of the state-owned smelters have been targeted to reduce sulfur emissions. The U.S. cost disadvantage may decline as developing countries become more concerned with the environmental damage caused by their copper industries.

Chile has 25 percent of the world's copper reserves, the most of any one country, and is the largest producer of mined copper in the world. Chile's production is expected to increase to over 2.2 million metric tons by the mid-1990s because of new production currently under development. The United States has 16 percent of the world's copper reserves and is the second-largest mine producer (figure 5). Total world mine production of copper, in terms of copper content, was 9.2 million metric tons in 1991 and has been increasing steadily since 1982, when production was 8 million metric tons.[21]

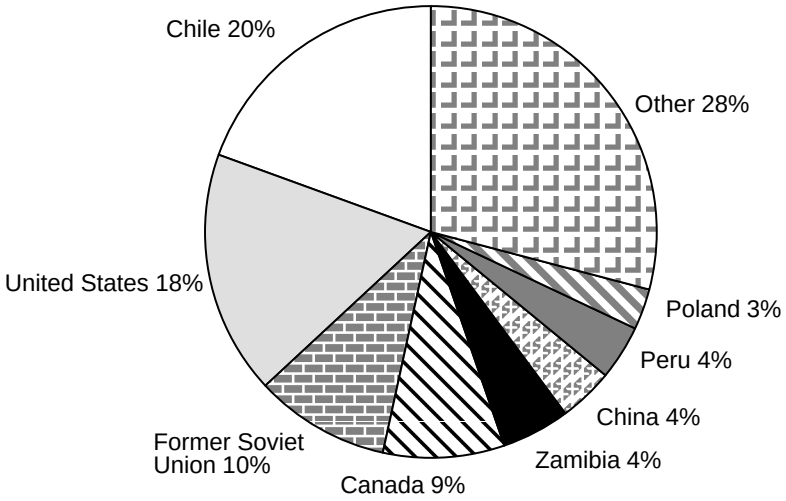
Since developing countries lack the industrial capacity to consume significant amounts of copper, trade patterns reflect large flows of various unwrought copper products to the industrialized countries. Refined copper is the most commonly traded item but there is also a substantial amount of trade in concentrates[22] and unrefined copper because countries that have little mine capacity have large smelter and refinery capacity. Notably, Japan, Germany, and Belgium have large smelting and refining industries that must import feed material. Total trade in copper concentrates in 1991, in terms of copper content, was approximately 1.7 million metric tons.[23] Canada, Chile, and the United States produce mined copper in excess of their substantial smelting capacity and are the largest concentrate exporters. Portugal and Papua New Guinea, which have no smelter capacity, are also major exporters. These five countries account for about 75 percent of concentrate exports. Japan is the largest importer of copper concentrates, accounting for over 60 percent of total imports. Other importers include Germany, Spain, and South Korea. Trade patterns in concentrates could change appreciably in the future because there are plans to build new smelters in the United States, Chile, Thailand, and Indonesia.

[21] Production figures in this paragraph compiled from World Bureau of Metal Statistics, *World Metal Statistics,* Oct. 1992.

[22] Trade in copper ores is insignificant because of the transportation costs involved. Almost all mines have concentrating plants nearby.

[23] Figures in this paragraph compiled from production statistics from World Bureau of Metal Statistics, *World Metal Statistics,* Oct. 1992.

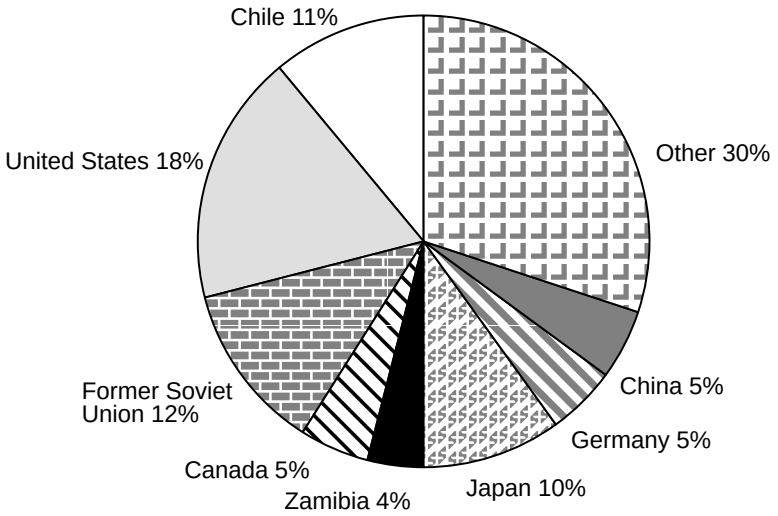
Figure 5
Unwrought copper: Mine production, by countries, 1991



Others	Percent
Australia	3
Mexico	3
Zaire	3
S. Africa	2
Indonesia	2
Philipines	2
Papua New Guinea	2
Others	11

Note.—Share figures based on copper content. Data for former Soviet Union and China estimated.
Source: World Bureau of Metal Statistics.

Figure 6
Unwrought copper: Refined copper production, by countries, 1991



Others	Percent
Belgium	3
Poland	3
Australia	3
S. Korea	2
Peru	2
Spain	2
Mexico	2
Others	13

Note.—Refined production includes production from secondary materials. Data for former Soviet Union and China are estimated.
Source: World Bureau of Metal Statistics.

Total world production of refined copper, from primary and secondary materials, was 10.9 million metric tons in 1991 and has been steadily increasing since 1982, when production was 9.5 million metric tons.[24] Because of the imbalance in smelting and refining capacity and large secondary production, there are significant differences in the countries that produce refined copper as compared with mined copper (figure 6). The United States produces refined copper from primary and secondary materials (Chile has little secondary production) and is the world's largest. Japan,

[24] Ibid.

Germany, and Belgium are large producers, based on importing large amounts of feed material. Chile, Zambia, Canada, and the United States are the largest exporters of refined copper, accounting for 60 percent of exports in 1991. The largest importers are Japan, Germany, France, Italy, the United States, and Taiwan, which together accounted for over 70 percent of imports in 1991.

Foreign Trade Measures

Tariff Measures

In general, foreign tariffs that apply to U.S. unwrought copper products are low and do not pose a significant barrier. However, the Japanese tariff on certain unwrought products is an exception; this tariff is variable, depending on the product's price, and according to industry representatives is designed to protect the Japanese copper smelting and refining industries. Since the Japanese market is large, the U.S. industry has been pressing for elimination of this tariff in the current round of GATT negotiations. Tariff rates in foreign countries tend to be much lower for unwrought copper products (and often there is no tariff) than for wrought copper products. The tariff rates for the main U.S. export products in the major U.S. foreign markets are presented in Table 8. Under the proposed NAFTA, most Mexican duties on imports of unwrought copper products from the United States would either be eliminated as of January 1, 1994 or eliminated by January 1, 1998 in 5 equal annual stages. Exceptions occur for copper waste/scrap and ashes/residues; duties on these products would be eliminated by January 1, 2003 in 10 equal annual stages.

Nontariff Measures

Several nontariff measures are of special concern to U.S. unwrought copper companies. These measures include alleged subsidies by foreign governments to their copper industries, restrictions on investment by U.S. companies in foreign countries, and restrictions on the trade of copper waste and scrap.

U.S. primary copper producers claim that foreign government subsidies to producers encourage domestic production despite unfavorable market conditions. Such practices reportedly contribute to global overproduction and price suppression. U.S. producers are especially concerned with subsidies to Canadian producers because the country is a large supplier to the U.S. market. The Nonferrous Metals Producers Committee (NFMPC), a trade organization representing several U.S. primary producers of copper, lead, and zinc, claims that Canadian primary metal producers receive Federal and Provincial Government subsidies, giving these industries an unfair advantage over their U.S. counterparts. The NFMPC claims that as tariffs between the two countries are phased-out, subsidized imports from Canada will increase and the ability of U.S. industries to compete will decline. In July 1989, in response to a petition from the NFMPC, the USTR identified the U.S. copper and lead industries as likely to face increased subsidized imports from Canada as tariffs are eliminated under the United States-Canada Free-Trade Agreement.[25] Subsequently, the NFMPC petitioned the USTR to compile all Government information on subsidies in the Canadian copper and lead industries and the zinc industry (because of its close association with the copper and lead industries).

No trade remedy actions have been requested in connection with this situation, although the NFMPC advocates inclusion of a subsidy discipline as an integral part of the NAFTA.[26] Such a discipline would clarify what subsidies would be allowed and which ones would not be allowed. A working group on subsidies, organized pursuant to the United States-Canada Free-Trade Agreement, was formed in 1989 to establish a subsidies understanding, but little progress has been made to date.

[25] Once an industry is identified pursuant to section 409(b) of the United States-Canada Free Trade Agreement Implementation Act of 1988, it may petition for further Government action.

[26] The proposed NAFTA does not contain a sudsidy discipline. However, a subsidies understanding is being discussed in the current round of GATT negotiations. If the GATT does conclude a subsidy discipline, then it would bind all members of NAFTA since all these countries are GATT parties.

Table 8
Tariff rates for selected U.S. unwrought copper products in foreign markets

Country	Concentrates	Waste/Scrap	Unrefined copper	Copper cathodes
Japan	Free	Free	(1)	(1)
Canada	Free	Free	Free	Free
EC countries	Free	Free	Free	Free
Mexico	10%	10%	10%	10%
Taiwan	Free	Free	Free	Free
South Korea	1%	2%[2]	4%[2]	7%[2]

[1] A three-tiered rate, depending on the customs value, applies to these products. When the customs value exceeds 500 yen per kilogram ($1.69 per pound), these products enter duty free. When the customs value is 485 yen per kilogram ($1.64 per pound) or lower, the duty rate is 15 yen per kilogram ($0.05 per pound). When the customs value is greater than 485 but less than 500 yen per kilogram, the duty rate is 500 yen minus the customs value. (Dollar conversions based on 1991 average exchange rate of $1 = 134.59 yen.)

[2] Scheduled to decrease to 1 percent, 3 percent, and 5 percent, respectively, by 1993.

According to industry sources, restrictions in some foreign countries may render investment untenable or undesirable. These restrictions include limitations on ownership and limitations on profit and capital repatriation. In Brazil, for example, the constitution does not permit majority foreign-owned mining ventures, and in Mexico foreign majority-owned mining companies may be formed but must become locally majority owned after 11 years.[27] However, many countries, interested in attracting investment, have liberalized investment laws and have embarked on privatization efforts to stimulate and modernize their mining sectors. Chile, Peru, Bolivia, Poland, and Australia have recently enacted new laws designed to attract additional foreign investment. Poland and Peru are attempting to privatize their state-owned copper companies. Chile, which has ruled out privatization of the state-owned copper company CODELCO, recently enacted a law that will permit CODELCO to form joint ventures with foreign firms to develop its extensive, unexploited mineral holdings. Brazil's present administration has proposed a constitutional amendment to allow foreign majority-owned mining ventures.

U.S. exports of copper waste and scrap have been hindered in two instances, only one of which has been resolved.[28] In May 1989 the United States began negotiations with the EC to settle a long-running dispute over the issue of EC export quotas on copper scrap. This action followed the filing of a petition pursuant to section 301 of the Trade Act of 1974 by the Copper and Brass Fabricators Council, Inc. (CBFC), a trade group that represents U.S. brass mills (consumers of copper scrap). The CBFC claimed EC brass mills were benefiting unfairly from artificially low scrap prices due to the export quotas, that scrap buyers were diverted to the U.S. market, and that this diversion increased U.S. scrap prices. The United States maintained that these quotas, which had been in effect for over 15 years, were a violation of the GATT, while the EC claimed these quotas were temporary and legal since they prevented or relieved shortages of essential materials. After negotiations failed to resolve the dispute, the United States appealed to the GATT Council, which subsequently convened an arbitration panel in November 1989. After the preliminary GATT Council meeting, EC officials requested a second round of negotiations with the United States. In an exchange of letters dated January 18, 1990, the EC acknowledged that market conditions no longer justified the continuation of quotas and agreed to end all export quotas on copper scrap.[29] In return the United States agreed to drop its GATT complaint and the CBFC withdrew its petition in February 1990.

Trade in copper waste and scrap with non-OECD countries will likely be restricted by the Basel Convention agreement on the transborder movement of hazardous wastes, which came into force in early 1992. The agreement allows countries to prohibit the importation of wastes that they deem hazardous and prohibits trade of hazardous materials with nonparticipating countries. Prior notification and consent by the destination country is required if hazardous wastes are shipped. The U.S. copper industry is concerned that the Basel agreement will be used to again hamper U.S. exports of copper waste and scrap. However, an agreement among the OECD countries specifically lists copper waste and scrap as nonhazardous waste and, therefore, not subject to the Basel agreement. The OECD agreement lists copper ashes and residues as semihazardous (making it subject to some controls) but does not list any copper articles as hazardous. Still, all non-OECD countries that are parties to the Basel Agreement are free to make their own determination of what is a hazardous waste and can legally restrict imports of those items.

Foreign Markets

Foreign Market Profile

The Asian Pacific region is a growing market for U.S. unwrought copper products because of strong automobile, air-conditioning, and consumer electronics industries in these markets (table 9). U.S. producers have a reputation as a reliable supplier in this region. One unwrought copper producer has changed its marketing emphasis to target the Asian region because it believes it will be more difficult to compete with imports from Canada in the eastern United States as tariffs between the United States and Canada are phased-out pursuant to the United States-Canada Free-Trade Agreement.[30] Another U.S. producer has Japanese partners in two of its copper mines. The Japanese partners take payment in copper concentrates, which are shipped to smelters in Japan. Growth of U.S. unwrought exports to the Asian region has also been aided by the closure of the Bougainville copper mine in Papua New Guinea, which supplied 2 percent of the world's mined copper (mostly to the Asian region) and which was forced to close in 1989 because of terrorist activity.

The United States is currently a large supplier of waste and scrap to Western Europe, but the integration of Eastern and Western European economies could decrease demand for U.S. waste and scrap. Large volumes of waste and scrap are reportedly available in Eastern Europe and will likely move to processors in Western Europe.

[27] Under the national treatment clause (article 1102) of the proposed NAFTA, the Mexican local ownership requirement would presumably not apply to U.S. companies.

[28] Trade in copper waste and scrap is substantial. In 1991, waste and scrap accounted for almost $450 million of U.S. exports, or 29 percent of total U.S. exports of unwrought copper products.

[29] Joseph L. Mayer, president of the Copper and Brass Fabricators Council, Inc., telephone interview by USITC staff, Washington DC, Jan. 1990.

[30] U.S. copper company official, telephone interview by USITC staff, Washington, DC, Jan. 31, 1990.

Table 9
Refined copper consumption in selected Asian markets and market share of U.S. imports, 1986-91

Market	1986	1987	1988	1989	1990	1991
Japan:						
Total (1,000 mt)	1,211	1,277	1,331	1,447	1,577	1,613
U.S. share (percent)	(1)	(1)	1	3	7	8
Taiwan:						
Total (1,000 mt)	156	208	215	315	265	397
U.S. share (percent)	1	(1)	1	23	25	22
South Korea:						
Total (1,000 mt)	262	259	266	252	324	344
U.S. share (percent)	(1)	1	2	1	2	4

[1] Less than 1 percent.

Source: Consumption figures from World Bureau of Metal Statistics; U.S. share figure estimated by staff of USITC.

Table 10
Unwrought copper: U.S. exports of domestic merchandise, by principal markets, 1986-91

(1,000 dollars)

Market	1986	1987	1988	1989	1990	1991
Japan	186,589	186,693	362,405	563,245	647,662	558,631
Taiwan	50,823	53,974	65,349	163,391	201,464	246,336
Canada	75,366	73,508	115,129	141,050	162,229	193,054
South Korea	59,849	63,594	180,571	177,895	186,745	177,458
China	12,197	2,577	29,754	50,180	77,016	78,720
Brazil	8,079	11,263	2,105	46,582	35,163	62,554
Mexico	7,416	32,962	71,039	70,192	61,438	36,213
Philippines	112	454	10,802	7,346	8,113	27,808
Hong Kong	4,440	4,772	4,976	6,077	14,220	19,429
Germany	21,981	20,180	151,179	121,813	39,025	16,892
All other	96,305	77,398	131,879	159,938	171,348	128,550
Total	523,157	527,375	1,125,188	1,507,709	1,604,423	1,545,645

Source: Compiled from official statistics of the U.S. Department of Commerce.

U.S. Exports

As a result of the U.S. industry's improved competitiveness in foreign markets, U.S. unwrought copper exports have almost tripled in value since 1986 (table 10). In 1992, wrought copper exports declined to $1.2 billion because of weakening consumption in Japan, South Korea, and Taiwan. Exports have become increasingly important to U.S. producers as producers have increased production. Exports of refined copper in 1991 accounted for about 14 percent of U.S. production, in contrast to less than 1 percent in 1986.

The principal unwrought products exported are copper concentrates, refined copper, and copper and copper alloy waste and scrap, accounting for 94 percent of unwrought copper exports in 1991. Exports during 1986-91 for all of these products increased, with exports of refined copper showing the largest increase, growing from less than 13 million kilograms in 1986 to over 270 million kilograms in 1991 (tables B-9 through B-11). The United States ranks as one of the top world exporters of concentrates and refined copper, although well behind Chile, and is the largest exporter of waste and scrap. The major exporters include the primary unwrought copper producers and dealers of waste and scrap.

U.S. Trade Balance

A competitive U.S. primary copper industry and strong demand in overseas markets, especially the Far East, contributed to an improvement in the U.S. trade balance in unwrought copper products, from a deficit of $332 million in 1986 to a surplus of $432 million in 1991 (table 11). In 1992, the surplus delined to $3.5 million, mainly because of lower exports to certain Far Eastern markets.

Table 11
Unwrought copper: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 1986-91[1]

(Million dollars)

Item	1986	1987	1988	1989	1990	1991
U.S. exports of domestic merchandise:						
Canada	75	74	115	141	162	193
Japan	187	187	362	563	648	559
Taiwan	51	54	65	163	201	246
Chile	(2)	(2)	0	2	(2)	(2)
South Korea	60	64	181	178	187	177
Mexico	7	33	71	70	61	36
Brazil	8	11	2	47	35	62
China	12	3	30	50	77	79
Peru	0	0	0	(2)	0	(2)
Philippines	(2)	(2)	11	7	8	28
All other	123	102	288	286	225	165
Total	523	527	1,125	1,508	1,604	1,546
EC-12	89	67	246	183	111	61
EFTA	8	11	7	16	16	10
OPEC	1	2	2	5	18	10
ASEAN	1	2	20	15	26	60
CBERA	(2)	1	1	3	4	5
U.S. imports for consumption:						
Canada	343	427	567	651	659	600
Japan	(2)	7	85	80	18	45
Taiwan	(2)	(2)	1	6	1	1
Chile	245	209	299	340	183	181
South Korea	1	(2)	(2)	(2)	(2)	(2)
Mexico	80	52	49	110	231	107
Brazil	(2)	(2)	2	51	26	57
China	(2)	(2)	3	1	1	1
Peru	0	0	0	0	15	53
Philippines	1	(2)	0	(2)	(2)	(2)
All other	185	222	245	150	84	68
Total	855	918	1,252	1,390	1,218	1,113
EC-12	8	58	46	18	19	32
EFTA	1	22	16	6	6	3
OPEC	(2)	(2)	2	12	12	15
SEAN	2	(2)	(2)	1	1	9
CBERA	2	4	9	11	12	11
U.S. merchandise trade balance:						
Canada	-267	-353	-452	-509	-496	-407
Japan	186	180	277	483	630	513
Taiwan	51	53	64	157	201	246
Chile	-245	-208	-299	-339	-183	-181
South Korea	59	63	181	178	187	177
Mexico	-72	-19	22	-40	-170	-71
Brazil	8	11	(2)	-4	9	5
China	12	2	27	49	76	78
Peru	0	0	0	(2)	-15	-53
Philippines	-1	(2)	11	7	8	28
All other	-62	-120	43	136	141	97
Total	-332	-391	-127	118	387	432
EC-12	81	8	199	165	92	30
EFTA	7	-11	-9	10	10	7
OPEC	1	1	-1	-7	7	-6
ASEAN	-1	2	20	14	24	50
CBERA	-2	-3	-7	-9	-8	-6

[1] Import values are based on customs value; export values are based on f.a.s. value, U.S. port of export.
[2] Less than $0.5 million.

Note.—Because of rounding, figures may not add to totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce.

WROUGHT COPPER

Product Coverage and Manufacturing Processes

Wrought copper products are generally commodity-type items, i.e., the basis for competition is price only. Buyers tend to have numerous suppliers, tend to purchase standard sizes and alloys, and are interested only in minimizing their costs. Price competition is intense, and although the price of wrought copper products can change substantially, reflecting the changing cost of the unwrought copper raw material, the margins of most wrought copper products remain low and fairly constant. There are some wrought copper products that are not commodity-type items. With these products, there may be some custom size requirements, specific alloy designations, or some other custom feature that requires a closer customer-supplier relationship. Although accounting for a small amount of wrought copper sales, these types of products are important because they are the most profitable.

Wrought copper products are classified in chapter 74 of the HTS. Table B-2 lists the fifty-five 8-digit HTS subheadings that cover wrought copper products, along with a short description.

The products of wrought copper, alloyed and unalloyed, are typically made by rolling, extruding, and drawing various unwrought copper and copper alloy shapes. The main wrought product groups are wires; plates, sheets, strip, and foil; bars, rods, and profiles; and tubes and pipes.

Making copper wire from continuously cast wire rod has almost completely replaced the old method of wiremaking, which involved hot-rolling and cold-drawing wire bars. Figure 7 shows the typical manufacturing processes used in wiremaking. Most copper and copper alloy wire is used for electrical purposes, but some quantities are used for nonelectrical purposes (called mechanical wire) in hardware, fittings, screening, woven-wire cloth, bolts, springs, rivets, and other products. Some bare wire is coated with other metals, usually tin, for electrical purposes, and brass wire is tin-plated for dressmaker's pins. Bare wire for electrical purposes may be stranded and then insulated with rubber, plastic, or paper in downstream operations.

The principal method for producing plates, sheets, and strip (i.e., flat products) is by hot-rolling and cold-rolling cakes. Figure 8 shows the typical manufacturing steps. A small amount of flat products is made by continuously casting to near-final thickness and then cold-rolling. Flat products are used in stamping operations in downstream operations.

Most copper foil is produced by rolling sheets or strip to narrower thicknesses, but it can also be produced by electro-depositional techniques. Foil can be alloyed, unalloyed, embossed, cut to shape, perforated, etched, coated, printed, colored, decorated, or backed. Rolled copper foil is intended for industrial applications, such as radiator fin material, and is usually a plain-surface product shipped in coils. Electro-deposited foil is used primarily in the manufacture of printed circuit boards as a laminating material.

Bars, rods, and profiles are used in downstream operations to make screws and other fasteners, forgings, etc. Figure 9 shows the steps used to manufacture these products. Low-fuming brazing rod is a general-purpose welding material of brass used to bond metal components together.[31]

Most tubes and pipes are the seamless type made by an extrusion process (figure 10), but some tubes and pipes are made by forming sheets into a round shape and welding the seam. The industry differentiates between plumbing and commercial tubes; plumbing tubes are used for standard plumbing applications such as feed water lines, whereas commercial tubes are used in heat-exchange applications and certain plumbing applications, where quality and tolerances are more important. Commercial tubes may be grooved on the interior wall to improve heat transfer capabilities.

Other wrought copper product groups include cast and powder products. Cast products are produced at foundries by pouring or injecting molten copper or copper alloys into a mold cavity, allowing the metal to cool and solidify, and then releasing the shape from the mold for finishing and use.[32] Molds may be made of sand, plaster, or metal. In die casting, the metal is injected into a metal mold under high pressure. Cast products are machined in downstream operations and become various builder's hardware and automobile parts.

Copper powders are used to make components for equipment using powder metallurgy techniques, which involve molding the powder into a shape and sintering (heating to a high temperature, but not melting). Copper powders are typically made using an atomization process. The most common copper powder products are self-lubricating bearings in automobiles. Copper flakes are produced from powders by milling, hammering, or stamping and are used in inks, in paints for marine and other all-weather application, in the manufacture of stamping and embossing materials, and for decorative papers and plastics.

Wrought copper products in this summary also include copper and copper alloy tube and pipe fittings, copper containers carried on the person, articles of copper coated or plated with precious metal, and a residual category of other copper articles.

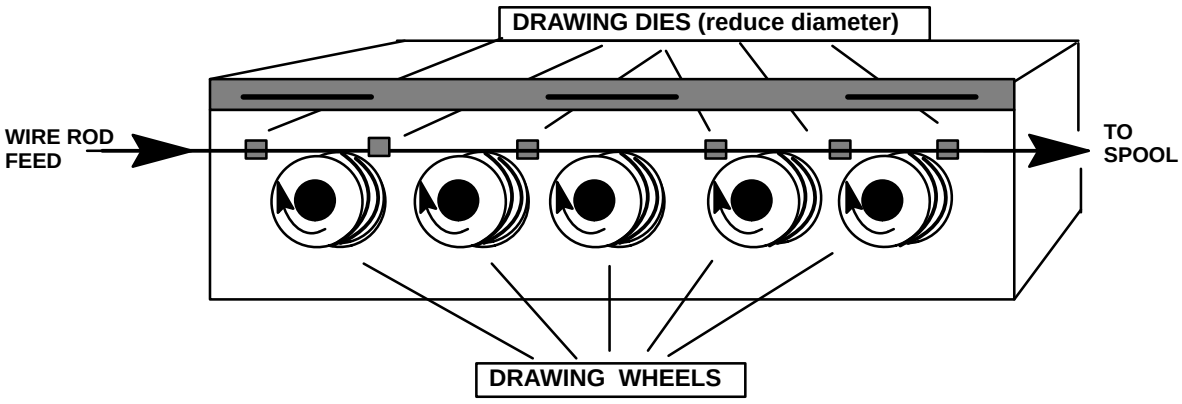
[31] Low-fuming brazing rod was the subject of an antidumping investigation. See "U.S. Tariff and Nontariff Measures" section.

[32] In this report foundry castings are differentiated from the generic castings of unwrought copper and copper alloys (i.e., billets, wire bars, etc.). Foundry castings are near-final-shape castings and are included as wrought products. The generic castings are made for further rolling and drawing operations and are included as unwrought products.

Figure 7
Wire: Production flowchart

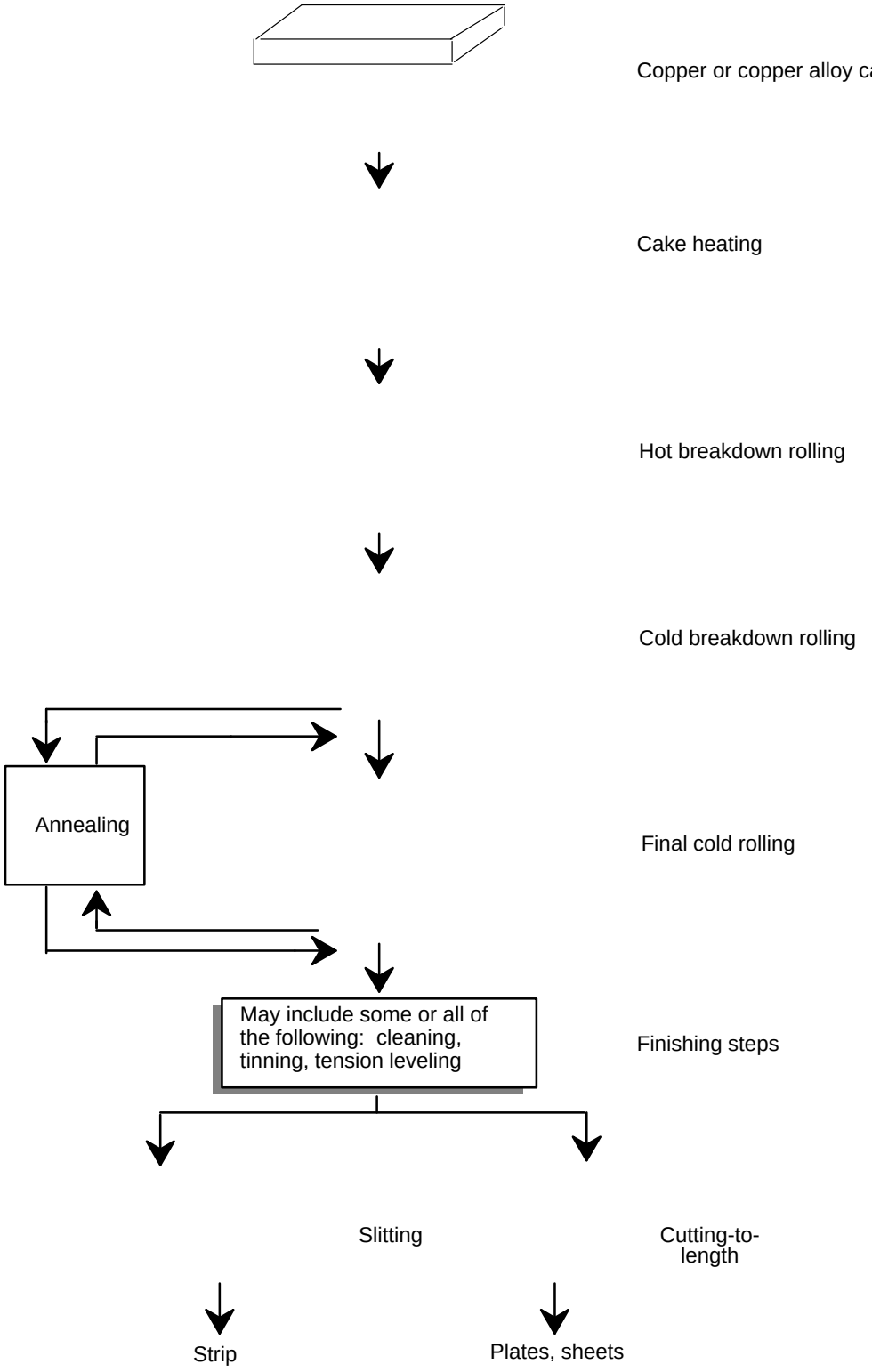
Wire Rod Production

Wire Production



Source: Southwire Co. brochure.

Figure 8
Plates, sheets, and strip: Production flowchart



Source: Olin Corp. brochure.

Figure 9
Bars, rods, and profiles: Production flowchart

Source: CRU Consultants, *The Copper Mill Products Industry—Scoping Study,* (Pittsburgh: The Center for Metals Production, Carnegie Mellon Research Institute), CMP report No. 89-6, Dec. 1989.

Figure 10
Tubes and pipes: Production flowchart

Source: CRU Consultants, *The Copper Mill Products Industry—Scoping Study,* (Pittsburgh: The Center for Metals Production, Carnegie Mellon Research Institute), CMP report No. 89-6, Dec. 1989.

Principal End Uses

About 60 percent of wrought copper products consumed in the United States are used for conducting electricity, mostly in the form of wire. Corrosion-resistance applications account for 22 percent of all uses. Other types of uses include heat transfer (e.g., radiators), structural components (i.e., load bearing), and architectural applications.

Wrought copper products are consumed by five major industry sectors: building construction (40 percent), electrical and electronic products (26 percent), industrial machinery and equipment (14 percent), transportation equipment (11 percent), and consumer and general products (9 percent). Within these sectors are several markets as shown in the tabulation at the end of this page.

U.S. Industry Profile

Industry Structure

The U.S. wrought copper industry is the largest in the world. The sector is not dominated by a small number of large companies as is the unwrought sector. There are a few large companies but also numerous medium-size and small companies, which constitute a major portion of production. Companies typically specialize in a subsector of the industry, concentrating resources on the efficient production of a limited number of product lines to remain competitive.

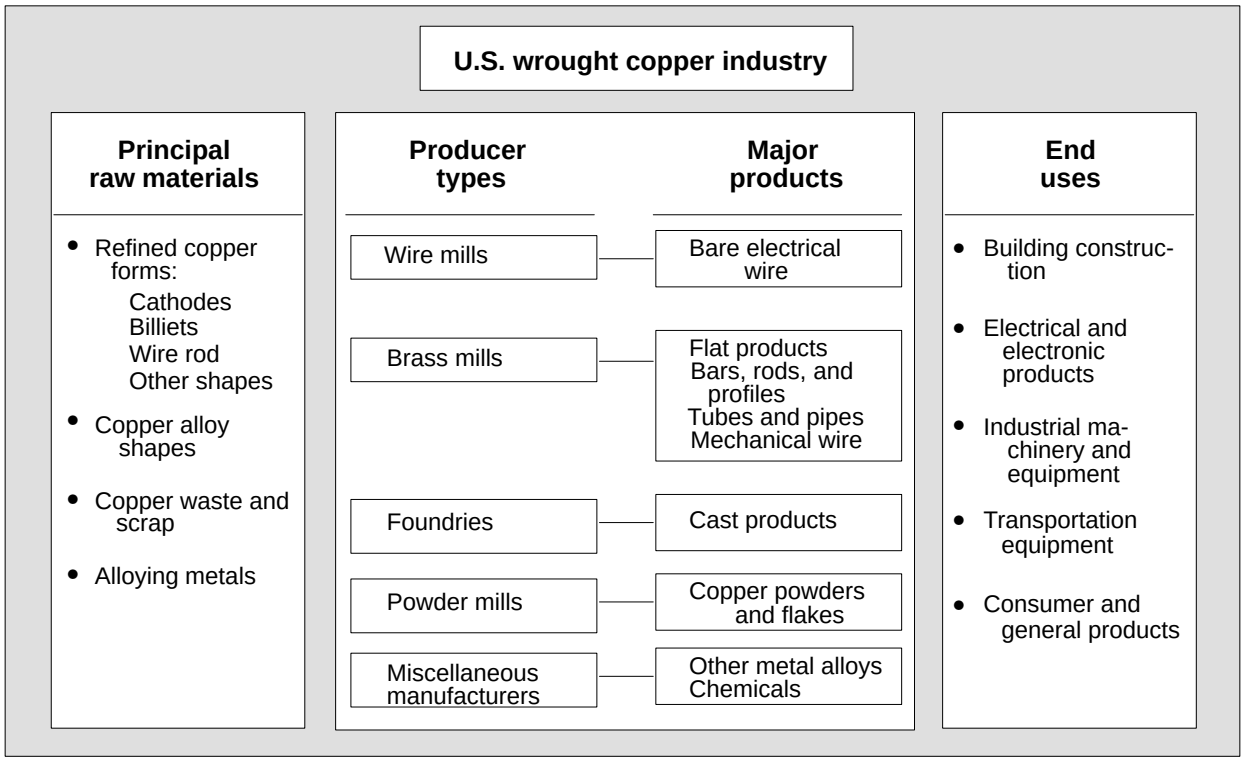
The principal raw materials, types of producers, major products, and product end uses of the U.S. wrought copper industry are shown in figure 11.[33] The industry is concentrated in the northeastern and midwestern regions of the United States. The number of firms, employment, and leading companies of major subsectors are shown in table 12.

One major structural change is the withdrawal of the unwrought companies from participation in the wrought sector. In the past a large portion of wire and brass mill production was owned by the major unwrought copper companies. Because of low margins in wrought copper products and increasing competition in the unwrought sector, these downstream facilities were sold, and many were subsequently established as private companies with a high level of debt (especially in the brass mill sector). By the early 1980s the unwrought companies were no longer major participants in the wrought copper industry. Phelps Dodge does still own some wire operations, however.

[33] Wrought copper products are included in the following SIC categories: SIC 3351, Rolling, Drawing, and Extruding of Copper; part of SIC 3357, Drawing and Insulating of Nonferrous Wire; part of SIC 3364, Nonferrous Die-Castings, Except Aluminum; SIC 3366, Copper Foundries; part of SIC 3399, Primary Metal Products, Not Elsewhere Classified; part of SIC 3432, Plumbing Fixtures and Trim; part of SIC 3494, Valves and Pipe Fittings, Not Elsewhere Classified; part of SIC 3497, Metal Foil and Leaf; and part of SIC 3499, Fabricated Metal Products, Not Elsewhere Classified.

Sector	Markets
Building construction	Plumbing and heating
	Building wiring
	Air-conditioning and commercial refrigeration
	Builder's hardware
	Architectural products
Electrical and electronic products	Telecommunications
	Power utilities
	Lighting and wiring devices
	Business electronics
Industrial machinery and equipment	In-plant equipment
	Industrial valves and fittings
	Nonelectrical instruments
	Off-highway vehicles
	Heat exchangers
Transportation equipment	Automobiles, trucks, and buses
	Railroad
	Marine
	Aircraft and aerospace
Consumer and general products	Appliances
	Cord sets
	Military and commercial ordnance
	Consumer electronics
	Fasteners and closures
	Coinage
	Utensils and cutlery
	Miscellaneous

Figure 11
U.S. wrought copper industry: Principal raw materials, producer types, major products, and end uses



Source: Compiled by the staff of the U.S. International Trade Commission.

Table 12
Structure of U.S. wrought copper industry

Sector	Number of firms	Employment	Leading companies
Wire mills	50	[1]64,000	Southwire, AT&T, Essex Group, General Cable Corp.
Brass mills:			
Flat products	33	([2])	Olin Corp., American Brass, Revere Copper Co.
Bars/rods/profiles	13	([2])	Cerro Metal Products, Mueller Brass, Hussey Copper.
Tubes/pipes	33	([2])	Cerro Copper Products, Wolverine Tube Co., Halstead Industries.
Foundries	385	[3]9,600	Lee Brass Co., Sloan Valve Co., Ford Meter Box Co., Mueller Foundry Co.
Powder mills	20	([4])	U.S. Bronze Powders, SCM Metal Products, Zinc Corp. of America.

[1] Disaggregated figure not available; this figure is for all wiremaking industries.
[2] Disaggregated figures not available; total brass mill employment is 22,600.
[3] Does not include copper die-casting operations.
[4] Not available, but industry sources estimate less than 500.

Note.—Number of firms figure represents estimate for 1990-91. Employment figures are 1989 data.

Source: U.S. Bureau of the Census; U.S. Department of Labor; CRU Consultants, *The Copper Mill Products Industry*; Metal Powders Industries Federation.

The four largest wire companies account for about one-third of total production. Some of the wire companies produce a variety of wire, but others concentrate on one type of wire production, e.g., building wire, magnet wire, or telecommunications wire. Wire companies are typically integrated with downstream cable and insulating operations.

The brass mill sector has changed substantially over the last 20 years. In the past, full-line brass mills were typical, but increasingly competitive market conditions caused by low-growth markets, over-capacity, and increased foreign competition forced companies to target dwindling investment resources on specific product lines, and three distinct subsectors evolved: flat products; bars, rods, and profiles; and tubes and pipes.

The two largest companies account for approximately 60 percent of capacity in the flat products subsector. Thirteen of these companies have their own casting operations to produce cakes and have rolling facilities; the companies making up the balance of the subsector purchase flat products and reroll, cut, and perform finishing operations. One flat products company uses a portion of its output in a downstream ammunition plant.

The bars/rods/profiles producing companies tend to specialize in copper or brass items. One brass producer uses a portion of its production in a downstream forging and screw machine operation.

The three largest tube and pipe companies account for about 60 percent of capacity. Twenty-two companies produce primary tubes and pipes from their own billets. Some of the flat products companies participate in this subsector by making welded tubes and pipes from sheets. The subsector also consists of 11 firms that purchase tubes and pipes and redraw them to smaller diameters.

The foundry sector has declined significantly over the last 20 years. This sector is characterized by a large number of small companies—in 1987 over 200 of these companies had less than 20 employees. Employment is only half of what it was in 1972, and the number of companies has shown a similar decline. Reportedly, contributing to the decline have been stringent Occupational Safety and Health Administration and Environmental Protection Agency regulations, which many small companies could not afford to meet, and substitution of plastics and aluminum.

Costs

As mentioned above, most wrought copper products are commodity items, which makes it difficult for producers to differentiate their products. These products include, for example, brass sheets and strip, copper plumbing tubes, and brass rods. Since margins are low, producers are concerned with minimizing production costs. For certain products (mostly for electronic applications and heat exchangers), companies have developed proprietary alloys and specially engineered products (e.g., thin-walled and inner-grooved tubing). These products create some differentiation, thus allowing greater margins and increased profitability.

Raw materials, labor, and energy costs are the major competitive factors in wrought products. The cost of copper and alloying metals typically accounts for over 50 percent of the production costs of most wrought copper products. Some companies have relocated to rural and southern areas of the country where labor rates are lower.

Globalization

In contrast to unwrought copper, most of the world's production of wrought copper is concentrated in the industrialized countries—the United States, Japan, and the Western European countries. Developing countries do not have as much competitive advantage in producing wrought copper products as they do with unwrought copper products, although these countries do have lower labor costs, which afford a marginal advantage. Although certain developing countries (e.g., Mexico and Brazil) have competitive wrought industries, they are small in terms of output compared with the industries in industrialized countries. In addition, tariffs on wrought products in industrialized countries are substantially higher than on unwrought products, which serve as a measure of protection.

Globalization is spurred by the desire to access the wrought copper markets and to gain technology. Because the industry is intensely cost competitive, it is particularly affected by changes in exchange rates, which can change the cost of foreign investments and relative production costs considerably. The decline in the value of the U.S. dollar since 1985 has made it more difficult for foreign products to compete in the U.S. market, but it also has made U.S. assets relatively inexpensive. Japanese companies have redirected exports to the Far East market as their relative costs increased, and they have increased investment in the U.S. market. U.S. companies have formed joint ventures with Japanese companies to acquire production technology, especially in highly engineered product lines, such as inner-grooved tubing and electro-deposited foil. One U.S. company has formed a joint venture with a German company and is planning to combine its knowledge of new alloys with the partner's production technology.

Some examples of globalization are as follows:

- Outokumpu, a large Finnish company involved in unwrought and wrought industries worldwide, owns American Brass, Valleycast (a copper alloy wire producer) and American Crucible Products (a bronze foundry);
- Wolverine Inc. (Canada) owns Wolverine Tube Co.;
- Poonsang (South Korea) recently completed a state-of-the-art flat products plant in Iowa, and also recently

purchased Great Lakes Metal Corp., a flat products producer in Euclid, OH;

- Oak-Mitsui Inc., a joint venture between Mitsui Mining and Smelting Co. (Japan) and Allied Signal, produces electro-deposited copper foil in New York;
- Kobe Steel (Japan) has a joint venture operation with Halstead to produce inner-grooved tubing in North Carolina;
- Sumitomo (Japan) and Phelps Dodge are planning a joint venture to produce magnet wire;
- Olin Corp. has joint venture companies in Germany and Japan, with Wieland Werke AG and Yamaha Metals Co., respectively.

U.S. investment abroad is much less prevalent. The declining dollar has made foreign investment more costly. Also, many U.S. wrought copper companies, especially in the brass mill sector, are highly leveraged private companies that have large debt service requirements, making it more difficult to raise investment funds.

Research and development

In an attempt to find high-margin products and to decrease production costs, significant research and development is expended by the wrought copper sector in developing new alloys and processes. For example, Olin Corp. has a research facility in Connecticut that has 85 scientists. This facility has developed improved brass alloys and is currently researching copper/beryllium alloys and alloys for mounting computer chips. Olin is also developing a process for the direct thin-casting of copper alloys, which could partially or wholly eliminate the need for hot- and cold-rolling and would be a significant technological advancement.

Environmental considerations

Environmental considerations in the wrought copper sector are much less significant than in the unwrought sector, although environmental regulations have contributed to the decline in the number of small foundries. The industry is concerned primarily about off-gases from melting operations and discarded process solutions. Most companies now have ducts and venting systems to take care of off-gases and have facilities for handling contaminated solutions. Industry sources indicate, however, that the use of toxic materials (e.g., cadmium and lead in certain copper alloys) may dictate higher operating costs in the future because of more stringent regulations that are likely to be enacted.

Consumer Characteristics and Factors Affecting Demand

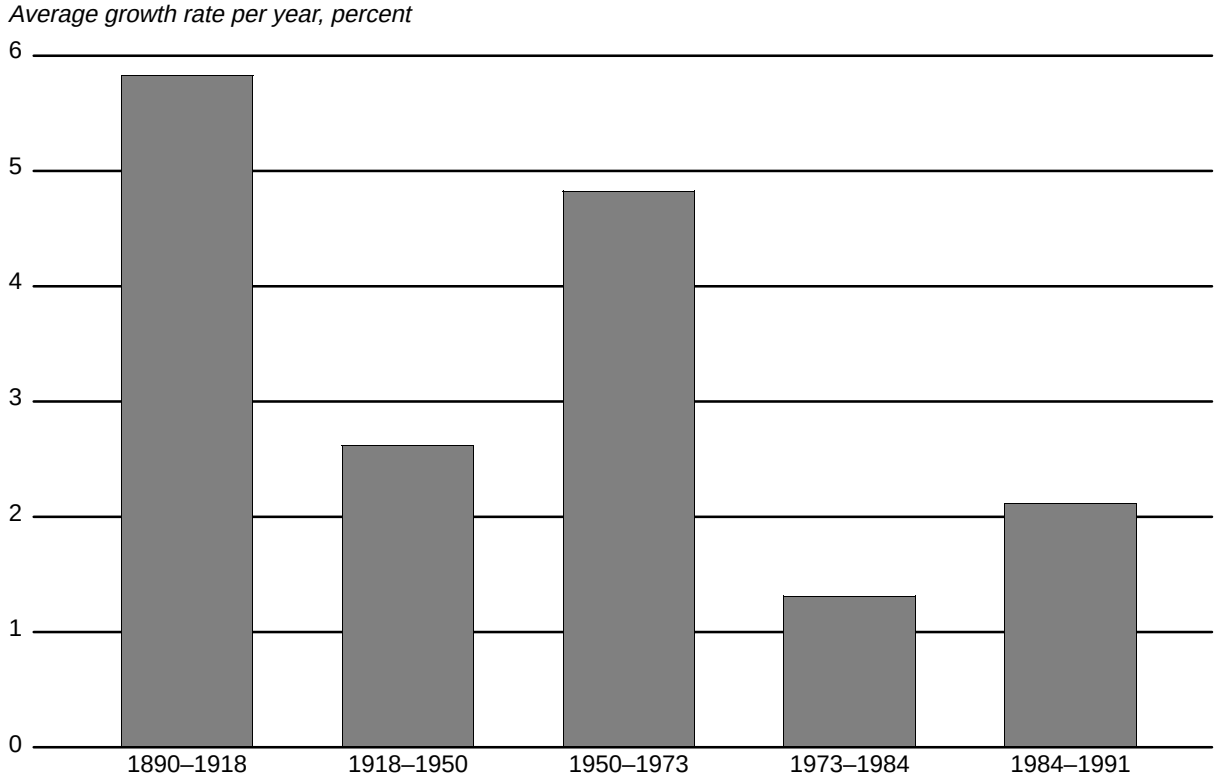
Demand for copper is strongly affected by industrial output. Consumers of wrought copper products produce goods such as insulated and uninsulated copper wire and cable, plumbing products, automobile parts, and air-conditioning parts and supplies. According to Roskill, a copper consulting group, copper demand declines by 2 percent for every 1-percent decline in industrial production.[34] For example, the annual growth in demand for copper during 1890-1918 (figure 12) reflected rapid industrial growth, and the expanding use of electric power and telephones and telegraphs contributed to a 5.8-percent average yearly increase in demand for copper. Demand growth slowed to less than half this amount in the following period due to decreased demand for munitions following World War I and due to world economic problems. Demand rebounded during 1950-73 because of strong industrial growth, Korean War demands, and stockpiling of copper by the U.S. Government. From 1973 to 1984, growth in industrial output was low and intensity-of-use declined, because of substitution. These trends led to slower growth in demand for copper. More recently there has been improvement because of strong world industrial growth, especially in the housing and automotive sectors. Demand for copper is particularly sensitive to the health of the housing and motor vehicle sectors (figure 13). As output in these sectors declines, copper stocks increase (indicating reduced demand). In recent years the decline in output has not resulted in increased stocks, because of strong demand outside the U.S. market.

Demand for copper is moderated by technological improvements that reduce material use or find substitutes for copper. Demand for copper has slowed over the last few decades because of changes in product design and competition from substitute materials. Product design changes include miniaturization in electronic systems; downsizing and downgauging in motor vehicles and air-conditioning tubing (i.e., smaller cars that require less wire and smaller radiators and heat exchangers that use thinner-walled tubing); and more efficient use in telecommunications (i.e., piggybacking of signals). Aluminum, a strong competitor because its specific weight is less than copper, has made significant inroads in power lines and automobile radiators. Plastics have been substituted for copper in plumbing applications, especially drain systems. Optical fibers have replaced copper as the most desired medium for telecommunications applications.

Several factors have encouraged greater demand growth for copper, however. Copper demand for electronic uses in automobiles has doubled since the early 1970s and has offset the trend of downsizing. The use of optical fibers in telecommunication systems has created more demand for computers and control systems that contain copper wire. The development of problems with plastic pipes in home plumbing systems has caused a return to copper tubes and pipes in some

[34] *The Economics of Copper*, 5th ed., 1990, Roskill Information Services Ltd., Aug. 1990, p. 3.

Figure 12
Copper: World demand growth rates per year, 1890-1991



Source: World Bank (1890-1984); estimated by staff of the U.S. International Trade Commission (1984-91).

cases. Other factors contributing to growing copper demand include fire hazard problems in aluminum building wire applications, increased demand for water sprinkler systems for fire control, and the demand for more bathrooms per house.[35]

Future global demand growth for copper has been estimated by various observers at 1 to 2 percent per year.[36] Infrastructure requirements (e.g., housing, telecommunications systems, and power systems) in Eastern Europe, the former Soviet Union, and developing countries could help push growth above the 2 percent figure.

U.S. Trade Measures

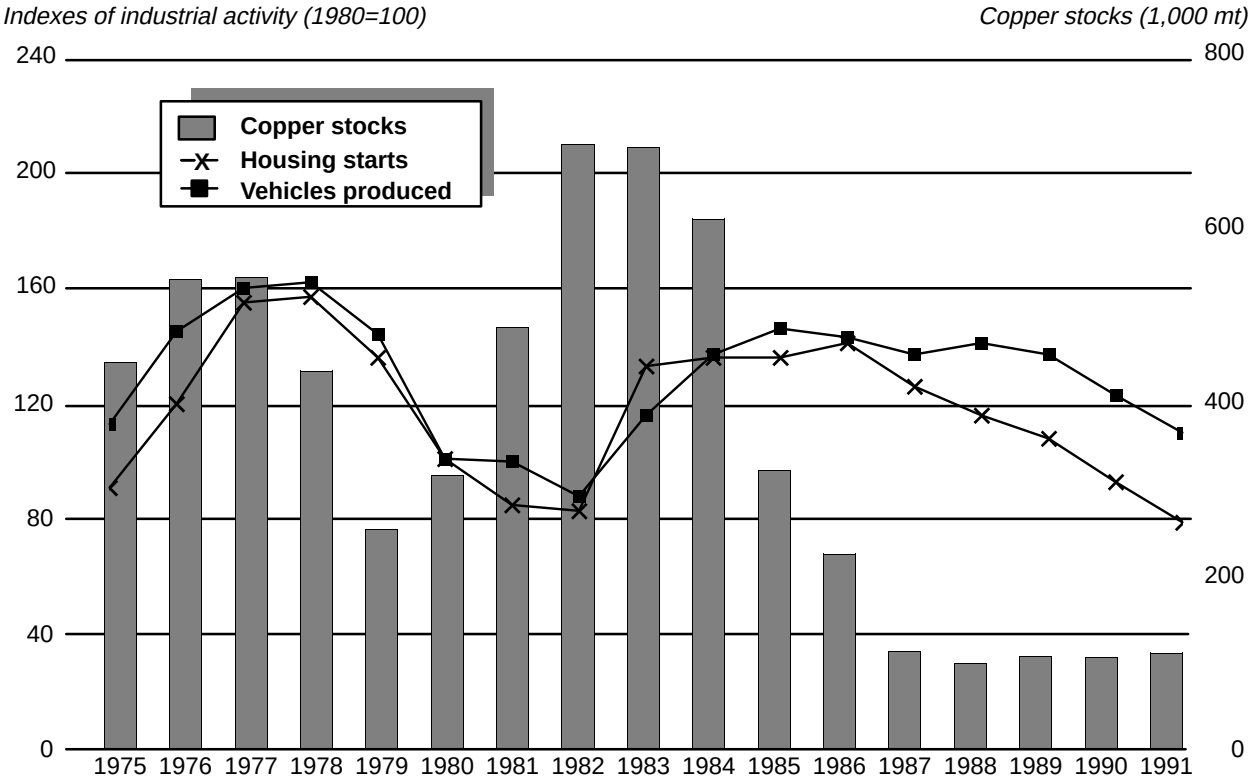
Tariff and Nontariff Measures

In most cases U.S. tariffs for wrought copper products are lower than their foreign counterparts. The U.S. column 1 tariff rates applicable to wrought copper products range from 1 percent to 11.2 percent (table B-2). The trade-weighted average tariff rate in 1991 was 2 percent for these products. Duties on eligible imports from Canada represent the 4th year of staged reductions under the United States-Canada Free-Trade Agreement, and these duties will be completely phased out by January 1, 1998. All products are eligible for duty-free treatment under the U.S.-Israel Free Trade Agreement, the Caribbean Basin Economic Recovery Act, and the Andean Trade Preference Act. All products except copper containers (HTS subheading 7419.99.15) are eligible for duty-free treatment under the Generalized System of Preferences. Brazil has been suspended from GSP treatment for certain brass bars and rods (HTS subheading 7407.21.90). Under the proposed NAFTA, most U.S. duties on imports of wrought copper products from Mexico would be eliminated as of January 1, 1994. Exceptions occur for the tariffs on unrefined copper, which would be eliminated by January 1, 1998 in 5 equal annual stages, and copper containers, which would be eliminated by January 1, 2003 in 10 equal annual stages.

[35] The number of houses constructed with two or more bathrooms increased from 73 percent in 1980 to 87 percent in 1990. U.S. Bureau of the Census, *Statistical Abstract of the United States: 1991,* 11th ed., Washington, DC, 1991, p. 721.

[36] Future demand growth from the following sources: PaineWebber, "Metal Stock Strategies," July 30, 1992, and John Champagne, "Magma Copper Company: A Strategy. *Continued*—for the 1990's," The 59th Annual Convention of the Wire Association International, Nov. 8, 1989

Figure 13
Selected U.S. industrial activity indexes and U.S. copper stocks, 1975-91



Source: Motor Vehicle Manufacturer's Association; *Economic Report of the President*; U.S. Bureau of Mines.

There do not appear to be any U.S. nontariff measures that affect trade or investment in the wrought copper sector. The United States is typically one of the world's largest importers of these goods, and there are numerous examples of foreign direct investment in the U.S. market.

U.S. Government Trade-Related Investigations

The brass mill segment of the domestic wrought copper industry has filed numerous petitions under the U.S. antidumping and countervailing-duty laws during the last 7 years. Table 13 summarizes the results of the investigations in which an affirmative determination was made. In these investigations the U.S. Department of Commerce found that certain brass products were being sold at less than fair value and that some foreign producers were being subsidized. Subsequently, the ITC determined that a domestic industry was materially injured or threatened with material injury by reason of dumped or subsidized imports.

Reportedly, these antidumping and countervailing duties have been a significant deterrent to imports of brass mill products.[37]

[37] CRU Consultants, *The Copper Mill Products Industry - Scoping Study,* (Pittsburgh: The Center for

U.S. Market

Consumption

Although less dramatic than the improvement in the unwrought copper sector, the competitiveness of the U.S. wrought copper industry in the U.S. market has improved, and imports as a percent of consumption have declined significantly during 1986-91 (table 14). Consumption of wrought copper products increased during 1986-88 because of strong growth in the U.S. economy but began to decline in 1989-91 as the economy deteriorated, particularly in the automotive and housing sectors. The improvement in the industry's competitive position is attributed mostly to a weakening U.S. dollar (which has lowered the industry's production costs relative to other world producers) and the effects of antidumping and countervailing duties on imports of certain brass mill products.

Production

U.S. production of wrought copper products has remained fairly constant over the last 20 years, fluctuating moderately in response to general economic conditions. Total production in 1991 was virtually the

[37] *Continued*—Metals Production, Carnegie Mellon Research Institute), CMP report No. 89-6, Dec. 1989.

Table 13
Summary of U.S. Government trade-related investigations,[1] Nov. 1985 through July 1988

Date	Product(s)	Target countries	Original duties applied	
			Antidumping	Countervailing
			Percent	
Nov. 1985	Low-fuming brazing copper wire and rod	New Zealand	26.93	([2])
Jan. 1986	Low-fuming brazing copper wire and rod	South Africa	3.3	([2])
Dec. 1986	Brass sheets and strip	Brazil	37.15	3.47
		Canada	2.51-11.54	([2])
		South Korea	7.17	([2])
Feb. 1987	Brass sheets and strip	France	42.05	7.24
		Italy	9.74	([2])
		Sweden	9.49	([2])
		West Germany	3.81-16.18	([2])
July 1988	Brass sheets and strip	Japan	13.3-57.98	([2])
		Netherlands	16.99	([2])

[1] Petition filed pursuant to title VII of the Tariff Act of 1930.
[2] Not applicable in these cases.

Note.—Date is time of final ITC determination.

Source: U.S. International Trade Commission; U.S. Department of Commerce.

Table 14
Certain wrought copper products:[1] U.S. production, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1986-91

Year	U.S. production[1]	U.S. exports	U.S. imports	Apparent U.S. consumption	Ratio of imports to consumption
	Million kilograms contained metal				*Percent*
1986	2,749	45	266	2,970	9
1987	3,018	63	257	3,212	8
1988	3,062	88	247	3,221	8
1989	2,984	110	218	3,092	7
1990	2,881	115	189	2,955	6
1991	2,729	118	157	2,768	6

[1] Includes copper and copper alloy wire; flat products; tubes and pipes; bars, rods, and profiles; foundry products; and powder products.

Source: Production from Copper Development Association; Exports and imports compiled from official statistics of the U.S. Department of Commerce.

same as in 1971. However, foundry and powder products have fallen consistently in production, reflecting the effects of plastic and aluminum substitution. Foundry and powder production are relatively small subsectors and have not significantly affected the overall trend in wrought copper production.

The industry's improved competitive position and the strength of the U.S. economy during 1986-89 caused production of wrought copper products to increase by about 10 percent from 1986 to 1989 (table 15). By 1991, however, a softening economy caused production to return to the 1986 level.

Imports

Imports from several major trading partners have declined significantly in recent years, and the domestic wrought copper industry has taken a larger share of the domestic market as a result. Although table 16 shows that wrought copper imports have increased in value terms during 1986-91, imports actually decreased in quantity terms. Imports from Canada of flat products and tubes/pipes by quantity have declined because of the closure of a Canadian brass mill in 1989 (tables B-6 and B-7). Imports from Germany and Japan of flat products also have declined (table B-7). Some of this

Table 15
Wrought copper: U.S. production of selected products, 1986-91

(Million kilograms metal content)

Product	1986	1987	1988	1989	1990	1991
Wire mill products	1,361	1,491	1,490	1,480	1,471	1,357
Brass mill products:						
Unalloyed:						
Bars/rods/profiles	42	51	59	57	60	54
Flat products[1]	112	131	137	130	130	116
Tubes/pipes	372	406	386	397	346	335
Mechanical wire	5	6	5	5	6	8
Alloyed:						
Bars/rods/profiles	320	363	372	345	331	333
Flat products[1]	254	284	312	284	274	273
Tubes/pipes	26	28	28	26	26	26
Mechanical wire	25	24	26	25	24	22
Foundry products	216	216	227	215	196	188
Powder products	16	18	20	19	17	16
Total	2,749	3,018	3,062	2,984	2,881	2,729

[1] Includes plates, sheets, strip, and rolled foil.

Note.—Because of rounding, figures may not add to totals shown.

Source: Copper Development Association.

Table 16
Wrought copper: U.S. imports for consumption, by principal sources, 1986-91

(1,000 dollars)

Source	1986	1987	1988	1989	1990	1991
Germany	129,348	124,339	136,300	139,525	134,880	116,394
Japan	126,314	145,244	147,521	141,415	122,222	115,742
Canada	74,950	99,474	132,752	129,204	86,442	97,000
Sweden	38,981	43,660	58,917	65,192	59,757	57,692
Taiwan	46,457	49,269	51,674	57,613	55,816	56,313
Mexico	22,830	48,713	90,286	83,875	67,012	46,533
United Kingdom	23,173	23,511	36,378	43,444	47,323	37,893
Netherlands	37,324	45,068	54,126	52,381	51,356	33,060
France	21,283	16,037	13,481	15,236	20,626	21,092
Brazil	26,513	15,100	24,649	24,873	24,060	20,767
All other	148,560	146,880	188,016	237,361	212,770	172,915
Total	695,733	757,295	934,100	990,119	882,264	775,401

Source: Compiled from official statistics of the U.S. Department of Commerce.

decline may be caused by the imposition of antidumping duties. Overall, imports of bars/rods/profiles, plates/sheets/strip, and tubes/pipes have declined over 40 percent, from 194 million kilograms in 1986 to 112 million kilograms in 1991 (tables B-6, B-7, and B-8).

In 1992, imports of wrought copper products were $815 million, an increase of about 5 percent from 1991. However, by quantity, imports of bars/rods/profiles, plates/sheets/strip, and tubes/pipes declined by 3 percent to 109 million kilograms in 1992.

The principal wrought products imported during this period include copper and brass bars and rods; brass wire; copper and brass sheets and strip; unbacked copper and brass foil; and copper, brass, copper-nickel, and copper-nickel-zinc tubes and pipes. In 1991 these articles accounted for over 65 percent of wrought copper imports. Several foreign countries have established niche markets in the United States: German flat products for the electrical and electronic markets; Japanese inner-grooved tubes for heat exchangers; and Japanese, Swedish, and Dutch strip for automotive radiator applications.

Imports under GSP duty-free provisions totaled about $131 million in 1991, about 17 percent of total wrought copper imports. The main beneficiary countries were Mexico, Brazil, Poland, and India. This provision especially helps Mexico, which is well situated to supply the West Coast markets. Most of these imports were brass bars and rods, brass wire, brass sheets and strip, copper and brass tubes and pipes, and brass plumbing goods. Duty-free imports under the United States-Israel FTA totaled about $3 million in 1991. Imports under CBERA provisions were negligible in 1991. Imports of products under provisions of HTS subheadings 9802.00.60 and 9802.00.80 had a customs value of $25 million and a

U.S. value (duty-free portion) of $16 million in 1991, with Japan and Canada as the principal supplying countries.

Foreign Industry Profile

In contrast to the unwrought copper industry, most of the world's wrought copper production is concentrated in the industrialized countries, and the developing countries rank only as minor producers. The United States and Japan dominate world wrought copper production, accounting for 23 percent and 22 percent, respectively, of production (figure 14), although EC countries as a block account for 38 percent of production. World production of wrought copper products was approximately 11.1 million metric tons in 1991, up from 8.5 million metric tons in 1982.[38] Production in developed countries is primarily for domestic consumption. Japan and Western Europe export about 10 percent of their production, compared with about 4 percent for the United States.

Several factors contribute to the lack of large downstream wrought copper industries in developing countries:

- Because wrought copper products are generally low-margin articles, it is difficult for them to attract investment;
- Developing countries lack the domestic industrial demand to consume wrought copper products; the industry would have to be developed for export markets;
- Tariffs for wrought copper products in developed countries (the principal consumers) are generally significantly higher than for unwrought products.

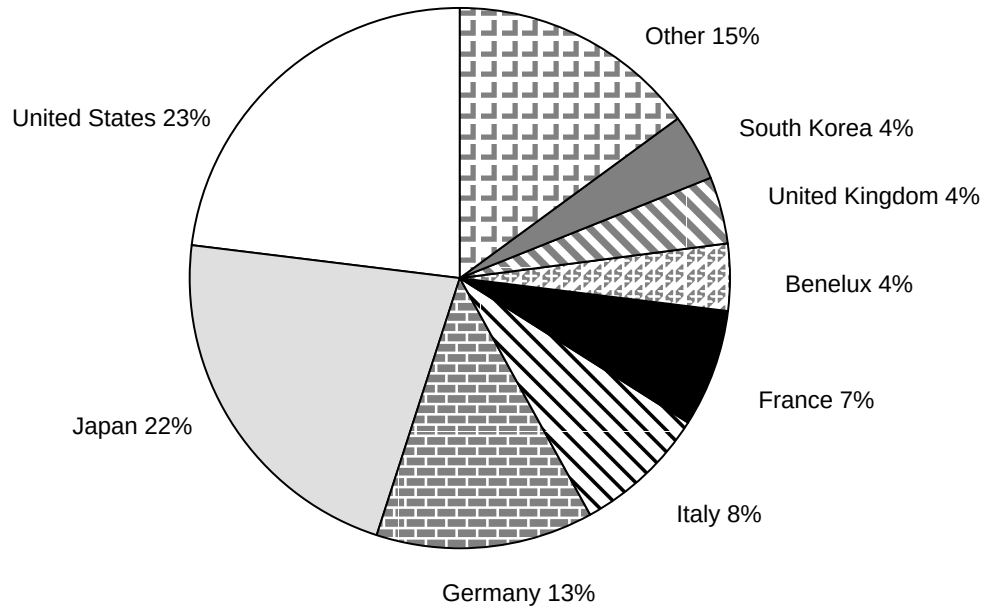
Although there are no large wrought copper industries in developing countries, several countries with competitive industries are significant participants in the trade of wrought copper products (e.g., Mexico and Brazil). These countries specialize in producing the commodity-type products in which their labor cost advantage is most apparent.

Structurally there are major differences between the U.S. wrought copper industry and its major competitors in Japan and Western Europe. U.S. companies generally have limited product lines with little horizontal and vertical integration and are much smaller than their foreign counterparts. Japanese and Western European production is concentrated in large, integrated companies. In Japan, companies that produce wrought copper typically own smelting and refining operations, full-line wrought production (i.e., wire, flat products, etc.), and fabrication operations.[39]

[38] Production figures in this paragraph from World Bureau of Metal Statistics, *World Metal Statistics*, Oct. 1992. Figures do not include production in centrally planned economies.

[39] The major Japanese wrought copper producers are Mitsubishi, Sumitomo, Kobe, Mitsui, and Nippon.

Figure 14
Wrought copper: World production, by countries, 1991



Note.—Does not include centrally planned economies.
Source: World Bureau of Metal Statistics.

These companies may also produce other unwrought and wrought metal products. In Europe the wrought copper industry has consolidated over the last several years and is now dominated by a few large companies that produce wire or a full line of brass mill products.[40] Competitively the U.S. industry is at a disadvantage because the limited product lines make revenues more susceptible to slowdowns in particular markets. Additionally, the ability of U.S. companies to raise investment capital is probably much more limited because of their relatively small size. This appears to be part of the reason that foreign companies have been able to place significant investment in the United States, whereas U.S. companies have little investment in foreign markets.

Competitiveness in marketing wrought copper products is a function of raw material and labor costs, tariff levels, energy costs, and the ability to develop new products. Wrought products are low-margin items, and even a small tariff can significantly affect the competitiveness of a product in a foreign market. Germany is considered a leader in developing labor-efficient rolling equipment. U.S. companies developed continuous-casting methods for producing wire rod and have marketed this equipment worldwide. Some U.S. companies have been successful in developing new alloys. Japanese companies have developed specially engineered wrought products.

Foreign Tariff and Nontariff Measures

Unlike foreign tariffs on unwrought products, which tend to be low, tariffs on wrought copper products may act as barriers to trade, since these products are generally sold with low margins. The tariff rates for the major U.S. markets are presented in table 17. Under the proposed NAFTA, Mexican duties on imports of wrought copper products from the United States would either be eliminated as of the beginning of 1994, or eliminated as of the beginning of 1998 or 2003 in 5 or 10 equal annual stages, respectively.

There are no foreign nontariff measures that appear to affect trade or investment in wrought copper products.

[40] The major European wiremaking companies are BICC Cables (U.K.), Pirelli Group (Italy), and Les Cables de Lyon (France). The major European brass mills are owned by Europa Metalli (Italy), Wieland Werke (Germany), and Outokumpu Oy (Finland).

Foreign Markets

Foreign Market Profile

Even though U.S. wrought copper exports have increased substantially during the last 6 years, the U.S. wrought copper industry plays a minor role in most foreign markets (table 18). The Canadian and Mexican markets are the exception, and U.S. products account for a significant share of consumption in these markets. Canada and Mexico are the largest U.S. markets because of the extent of economic integration between these three markets, especially in the automotive sector. U.S. automotive companies have set up operations in these countries and have created a demand for upstream parts produced in the United States.

One of the fastest growing markets is the Far East region outside of Japan. An expanding manufacturing base and increasing demand for air-conditioning systems have created strong demand for wrought copper products. The Japanese are large suppliers to this market, but U.S. producers are increasing exports to this part of the world.

The decline in value of the U.S. dollar relative to foreign currencies has contributed to a substantial improvement in the ability of U.S. companies to compete in foreign markets. Figure 15 shows the decline in value of the dollar since 1985, which has been especially evident against the Japanese yen and German mark. In Japan's case, the weakening dollar has contributed to a shift in marketing emphasis from the United States to the Far East.

Table 17
Tariff rates for selected U.S. wrought copper products in foreign markets and comparative U.S. tariffs

Country	Bars/rods/ profiles	Flat products[1]	Tubes/pipes
Japan	4.6-5.8%	4.6-5.2%	5.2-6.6%
Canada	Free-6.1%	Free-6.1%	Free-6.1%
EC countries	6%	6-6.5%	6%
Mexico	10-15%	10%	10-15%
Taiwan	3-4%	4-10%	5%
South Korea	9%[2]	9%[2]	9%[2]
United States	1-6.3%	1-6.7%	1.5-5.1%

[1] Includes plates, sheets, strip, and foil

[2] Scheduled to decrease to 8 percent by 1993.

Note.—Except for Canada, tariffs are each country's most-favored-nation rate. Canadian tariff is the 1992 U.S.-Canada Free-Trade Agreement rate.

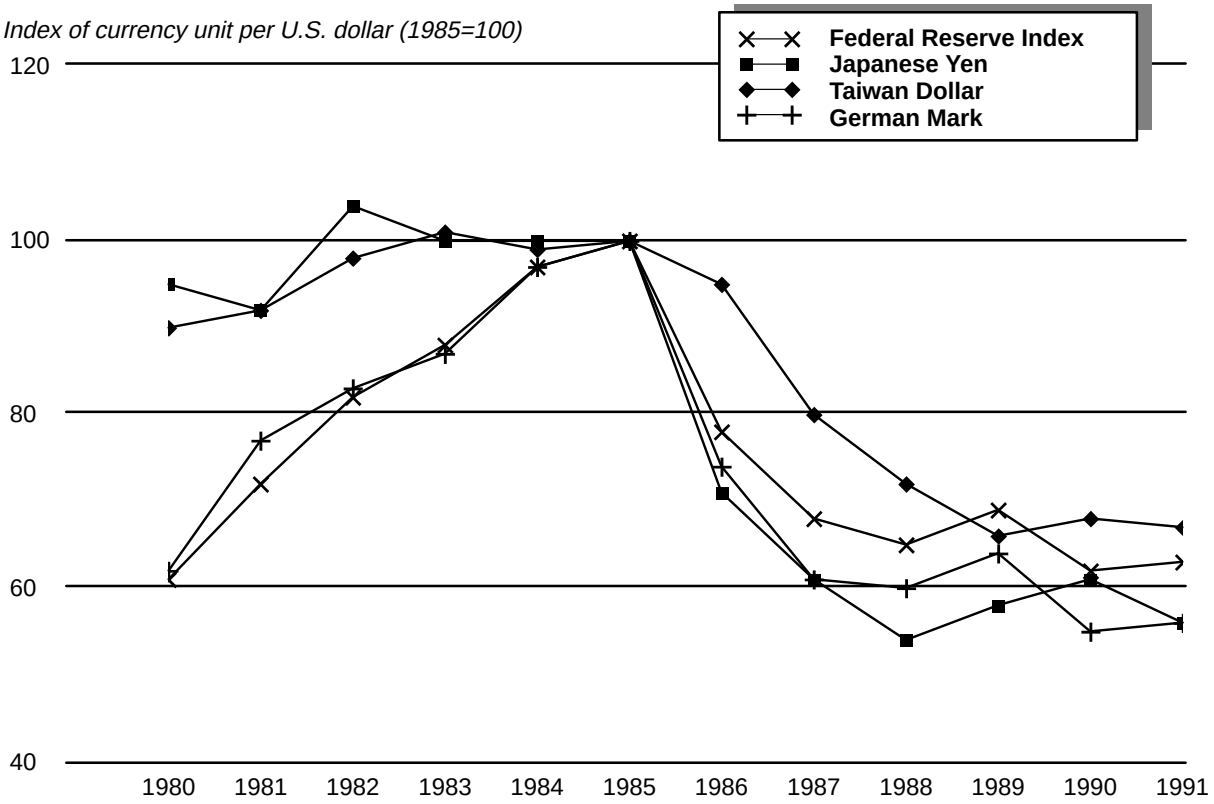
Table 18
Consumption of certain wrought copper products[1] in foreign markets

Market	1991 consumption	Percent supplied by U.S. exports
	Metric tons	
Japan	2,273,011	(2)
Germany	1,266,436	(2)
France	637,917	(2)
United Kingdom	416,660	(2)
Canada[3]	279,545	11
Mexico[3]	87,240	30

[1] Includes wire; bars, rods, and profiles; plates, sheets, and strip; and tubes and pipes.
[2] Less than 1 percent.
[3] Data for 1989 were used (latest available).

Source: Consumption calculated from production, import, and export data from World Bureau of Metal Statistics. Exports compiled from official statistics of the U.S. Department of Commerce.

Figure 15
Selected exchange-rate indexes, 1980-91



Source: Based on exchange rates and index from Federal Reserve Bulletin.

U.S. Exports

The importance of exports to U.S. producers increased during the last 6 years for many wrought products as their ability to compete in foreign markets increased. For example, U.S. exports of bars, rods, and profiles as a portion of U.S. production have increased from 3 percent in 1986 to 10 percent in 1990. U.S. exports of plates, sheets, strip, tubes, and pipes as a portion of U.S. production have also increased, from 2 percent in 1986 to 6 percent in 1990.

U.S. exports of wrought copper and related products have more than doubled in value during 1986-91 (table 19). In 1992, exports of these products increased to $769 million. The increase in exports to Canada has been aided by the closure of a Canadian brass mill. Total exports of these products in quantity terms have almost tripled, increasing from 27 million

Table 19
Wrought copper: U.S. exports of domestic merchandise, by principal markets, 1986-91

(1,000 dollars)

Market	1986	1987	1988	1989	1990	1991
Canada	73,818	102,646	143,495	169,589	244,691	234,602
Mexico	53,994	66,797	119,813	123,801	116,744	138,940
Germany	14,953	17,837	21,411	17,214	23,162	31,485
Taiwan	9,054	13,301	19,829	27,914	39,651	31,138
Japan	10,613	25,664	32,126	33,058	29,867	27,528
France	14,527	16,669	19,467	17,589	17,057	19,810
Hong Kong	17,846	17,080	20,986	18,950	24,550	17,420
Singapore	5,561	7,002	8,414	11,233	12,892	15,984
United Kingdom	20,892	24,340	24,125	22,006	24,724	15,676
Saudi Arabia	7,141	6,462	10,168	6,353	8,146	11,375
All other	82,404	116,340	141,424	154,638	133,806	135,584
Total	310,803	414,138	561,258	602,345	675,290	679,542

Source: Compiled from official statistics of the U.S. Department of Commerce.

kilograms in 1986 to over 77 million kilograms in 1991. Tables B-12 through B-14 show exports in terms of quantity, value, and unit value for bars, rods, and profiles; flat products; and tubes and pipes.

The principal products exported are copper and copper alloy bars and rods; copper and copper alloy wire; copper and copper alloy sheets and strip; copper-clad laminates; copper tubes and pipes; copper and copper alloy tube and pipe fittings; and brass plumbing fittings. These products accounted for over 85 percent of wrought copper exports in 1991.

U.S. Trade Balance

The trade balance in wrought copper products was fairly consistent during 1986-89 but improved from a deficit of $388 million in 1989 to a deficit of $96 million in 1991 (table 20). Most of the improvement occurred because the trade surplus with Canada increased, rising from $40 million in 1989 to $138 million in 1991, primarily because a Canadian brass mill closed. In 1992, further improvement in the trade balance occurred as the deficit decreased to $46 million.

Table 20
Wrought copper: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 1986-91[1]

(Millions dollars)

Item	1986	1987	1988	1989	1990	1991
U.S. exports of domestic merchandise:						
Canada	74	103	143	170	245	235
Mexico	54	67	120	124	117	139
Germany	15	18	21	17	23	31
Japan	11	26	32	33	30	28
Taiwan	9	13	20	28	40	31
Sweden	3	2	4	3	3	3
United Kingdom	21	24	24	22	25	16
Netherlands	4	6	10	10	12	10
France	15	17	19	18	17	20
Switzerland	5	8	9	10	8	10
All other	101	130	158	168	157	157
Total	311	414	561	602	67	680
EC-12	69	83	92	79	93	94
EFTA	.9	11	14	14	14	14
OPEC	16	19	28	21	19	24
ASEAN	11	17	20	33	36	36
CBERA	14	22	28	23	15	13
U.S. imports for consumption:						
Canada	75	99	133	129	86	97
Mexico	23	49	90	84	67	47
Germany	129	124	136	140	135	116
Japan	126	145	148	141	122	116
Taiwan	46	49	52	58	56	56
Sweden	39	44	59	65	60	58
United Kingdom	23	24	36	43	47	38
Netherlands	37	45	54	52	51	33
France	21	16	13	15	21	21
Switzerland	11	13	15	15	14	16
All other	164	149	198	247	223	178
Total	696	757	934	990	882	775
EC-12	244	239	266	285	292	236
EFTA	56	67	93	104	98	97
OPEC	1	([2])	([2])	1	2	([2])
ASEAN	3	5	7	6	6	9
CBERA	([2])	1	1	([2])	1	1
U.S. merchandise trade balance:						
Canada	-1	3	11	40	158	138
Mexico	31	18	30	40	50	92
Germany	-114	-107	-115	-122	-112	-85
Japan	-116	-120	-115	-108	-92	-88
Taiwan	-37	-36	-32	-30	-16	-25
Sweden	-36	-42	-55	-62	-57	-54
United Kingdom	-2	1	-12	-21	-23	-22
Netherlands	-33	-39	-44	-43	-40	-23
France	-7	1	6	2	-4	-1
Switzerland	-6	-4	-6	-6	-6	-6
All other	-63	-18	-40	-79	-66	-21
Total	-385	-343	-373	-388	-207	-96
EC-12	-175	-156	-174	-206	-199	-142
EFTA	-47	-56	-80	-90	-84	-82
OPEC	16	19	28	20	17	24
ASEAN	8	11	13	26	29	27
CBERA	14	21	27	23	14	12

[1] Import values are based on customs value; export values are based on f.a.s. value, U.S. port of export. U.S. trade with East Germany is included in "Germany."

[2] Less than $0.5 million.

Note.—Because of rounding, figures may not add to totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce.

APPENDIX A
EXPLANATION OF TARIFF AND TRADE AGREEMENT TERMS

TARIFF AND TRADE AGREEMENT TERMS

The ***Harmonized Tariff Schedule of the United States*** (HTS) replaced the *Tariff Schedules of the United States* (TSUS) effective January 1, 1989. Chapters 1 through 97 are based on the internationally adopted Harmonized Commodity Description and Coding System through the six-digit level of product description, with additional U.S. product subdivisions at the eight-digit level. Chapters 98 and 99 contain special U.S. classification provisions and temporary rate provisions, respectively.

Rates of duty in the ***general*** subcolumn of HTS column 1 are most-favored-nation (MFN) rates; for the most part, they represent the final concession rate from the Tokyo Round of Multilateral Trade Negotiations. Column 1-general duty rates are applicable to imported goods from all countries except those enumerated in general note 3(b) to the HTS, whose products are dutied at the rates set forth in ***column 2***. Goods from Armenia, Bulgaria, the People's Republic of China, Czechoslovakia, Estonia, Hungary, Latvia, Lithuania, Moldova, Mongolia, Poland, Russia, the Ukraine, and Yugoslavia are currently eligible for MFN treatment. Among articles dutiable at column 1-general rates, particular products of enumerated countries may be eligible for reduced rates of duty or for duty-free entry under one or more preferential tariff programs. Such tariff treatment is set forth in the ***special*** subcolumn of HTS column 1. Where eligibility for special tariff treatment is not claimed or established, goods are dutiable at column 1-general rates.

The ***Generalized System of Preferences*** (GSP) affords nonreciprocal tariff preferences to developing countries to aid their economic development and to diversify and expand their production and exports. The U.S. GSP, enacted in title V of the Trade Act of 1974 and renewed in the Trade and Tariff Act of 1984, applies to merchandise imported on or after January 1, 1976, and before July 4, 1993. Indicated by the symbol "A" or "A*" in the special subcolumn of column 1, the GSP provides duty-free entry to eligible articles the product of and imported directly from designated-beneficiary developing countries, as set forth in general note 3(c)(ii) to the HTS.

The ***Caribbean Basin Economic Recovery Act*** (CBERA) affords nonreciprocal tariff preferences to developing countries in the Caribbean Basin area to aid their economic development and to diversify and expand their production and exports. The CBERA, enacted in title II of Public Law 98-67, implemented by Presidential Proclamation 5133 of November 30, 1983, and amended by the Customs and Trade Act of 1990, applies to merchandise entered, or withdrawn from warehouse for consumption, on or after January 1, 1984. This tariff preference program has no expiration date. Indicated by the symbol "E" or "E*" in the special subcolumn of column 1, the CBERA provides duty-free entry to eligible articles, and reduced-duty treatment to certain other articles, which are the product of and imported directly from designated countries, as set forth in general note 3(c)(v) to the HTS.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "IL" are applicable to products of Israel under the ***United States-Israel Free Trade Area Implementation Act*** of 1985 (IFTA), as provided in general note 3(c)(vi) of the HTS. Where no rate of duty is provided for products of Israel in the special subcolumn for a particular provision, the rate of duty in the general subcolumn of column 1 applies.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "CA" are applicable to eligible goods originating in the territory of Canada under the ***United States-Canada Free-Trade Agreement*** (CFTA), as provided in general note 3(c)(vii) to the HTS.

Preferential nonreciprocal duty-free or reduced-duty treatment in the special subcolumn of column 1 followed by the symbol "J" or "J*" in parentheses is afforded to eligible articles the product of designated-beneficiary countries under the ***Andean Trade Preference Act*** (ATPA), enacted in title II of Public Law 102-182 and implemented by Presidential Proclamation 6455 of July 2, 1992 (effective July 22, 1992), as set forth in general note 3(c)(ix) to the HTS.

Other special tariff treatment applies to particular ***products of insular possessions*** (general note 3(a)(iv)), goods covered by the ***Automotive Prod-***

ucts Trade Act (APTA) (general note 3(c)(iii)) and the ***Agreement on Trade in Civil Aircraft*** (ATCA) (general note 3(c)(iv)), and ***articles imported from freely associated states*** (general note 3(c)(viii)).

The ***General Agreement on Tariffs and Trade*** (GATT) (61 Stat. (pt. 5) A58; 8 UST (pt. 2) 1786) is the multilateral agreement setting forth basic principles governing international trade among its more than 90 signatories. The GATT's main obligations relate to most-favored-nation treatment, the maintenance of scheduled concession rates of duty, and national (nondiscriminatory) treatment for imported products. The GATT also provides the legal framework for customs valuation standards, "escape clause" (emergency) actions, antidumping and countervailing duties, and other measures. Results of GATT-sponsored multilateral tariff negotiations are set forth by way of separate schedules of concessions for each participating contracting party, with the U.S. schedule designated as schedule XX.

Officially known as "The Arrangement Regarding International Trade in Textiles," the ***Multifiber Arrangement*** (MFA) provides a framework for the negotiation of bilateral agreements between importing and producing countries, or for unilateral action by importing countries in the absence of an agreement. These bilateral agreements establish quantitative limits on imports of textiles and apparel, of cotton and other vegetable fibers, and of wool, man-made fibers, and silk blends, in order to prevent market disruption in the importing countries—restrictions that would otherwise be a departure from GATT provisions. The United States has bilateral agreements with more than 30 supplying countries, including the four largest suppliers: China, Hong Kong, the Republic of Korea, and Taiwan.

APPENDIX B
STATISTICAL TABLES

Table B-1
Unwrought copper: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty as of Jan. 1, 1992		U.S. exports, 1991	U.S. imports, 1991
		General	Special[1]		
		Percent		*Million dollars*	
2603.00.00	Copper ores and concentrates	[2]0.1	Free (A[3], CA, E, IL, J)	382	67
2620.30.00	Ash and residues (other than from the manufacture of iron or steel), containing mainly copper	[2]0.1	Free (A, CA, E, IL, J)	14	2
7401.10.00	Copper mattes	[2]0.2	Free (A,[3] E, IL, J); 0.1%[2] (CA)	1	3
7401.20.00	Cement copper (precipitated copper)	[2]1.7	Free (A, E, IL, J); 0.3%[2] (CA)	2	([4])
7402.00.00	Unrefined copper; copper anodes for electrolytic refining	[2]1	Free (A,[5] E, IL, J); 0.2%[2] (CA)	50	146
7403.11.00	Cathodes and sections of cathodes of refined copper	1	Free (A,[6] E, IL, J); 0.2% (CA)	602	644
7403.12.00	Wire bars of refined copper	1	Free (A,[6] E, IL, J); 0.2% (CA)	1	1
7403.13.00	Billets of refined copper	1	Free (A,[6] E, IL, J); 0.2% (CA)	10	9
7403.19.00	Articles of refined copper, n.e.s.i	1	Free (A,[6] E, IL, J); 0.2% (CA)	11	22
7403.21.00	Copper-zinc base alloys (brass)	1	Free (A,[6] E, IL, J); 0.2% (CA)	9	3
7403.22.00	Copper-tin base alloys (bronze)	1	Free (A,[6] E, IL, J); 0.2% (CA)	3	([4])
7403.23.00	Copper-nickel base alloys (cupro-nickel) or copper-nickel-zinc base alloys (nickel silver).	1	Free (A,[6] E, IL, J); 0.2% (CA)	4	1
7403.29.00	Copper alloys other than copper-zinc base, copper-tin base, copper-nickel base (cupro-nickel), or copper-nickel-zinc base	1	Free (A,[6] E, IL, J); 0.2% (CA)	8	1
7404.00.00	Copper waste and scrap	Free		446	212
7405.00.10	Master alloys of copper containing by weight 5% or more but not more than 15% of phosphorous	2.6	Free (A, E, IL, J); 0.5% (CA)	1	2
7405.00.60	Master alloys of copper, not containing by weight 5% or more but not more than 15% of phosphorous	6	Free (A, E, IL, J); 1.2% (CA)	1	1
	Total and weighted average, all unwrought products	[7]0.4		1,546	1,113

[1] Programs under which special tariff treatment may be provided and the corresponding symbols for such programs as they are indicated in the "Special" subcolumn, are as follows: Generalized System of Preferences (A); Automotive Products Trade Act (B); Agreement on Trade in Civil Aircraft (C); United States-Canada Free-Trade Agreement (CA); Caribbean Basin Economic Recovery Act (E); United States-Israel Free Trade Area (IL); and Andean Trade Preference Act (J).
[2] Estimated ad valorem equivalent.
[3] Mexico has been proclaimed by the President as noneligible for GSP treatment for articles included under this HTS subheading.
[4] Less than $500,000.
[5] Chile and Mexico have been proclaimed by the President as noneligible for GSP treatment for articles included under this HTS subheading.
[6] Chile has been proclaimed by the President as noneligible for GSP treatment for articles included under this HTS subheading.
[7] Average duty rate weighted by value of 1991 imports.

Note.—Because of rounding, figures may not add to the totals shown.

Source: U.S. exports and imports compiled from data of the U.S. Department of Commerce.

Table B-2
Wrought copper: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty as of Jan. 1, 1992		U.S. exports, 1991	U.S. imports, 1991
		General	Special[1]		
		Percent		*Million dollars*	
7406.10.00	Copper powders of non-lamellar structure	5.4	Free (A, E, IL, J); 3.2% (CA)	8	3
7406.20.00	Copper powders of lamellar structure; copper flakes	3	Free (A, E, IL, J); 1.8% (CA)	6	7
7407.10.10	Profiles of refined copper	6.3	Free (A, E, IL, J); 3.7% (CA)	4	14
7407.10.50	Bars and rods of refined copper	1	Free (A, E, IL, J); 0.6% (CA)	28	29
7407.21.10	Profiles of copper-zinc base alloys (brass)	3.2	Free (A, E, IL, J, CA[2])	2	5
7407.21.50	Low-fuming brazing rods of copper-zinc base alloys (brass)	2.2	Free (A, E, IL, J, CA[2])	0	2
7407.21.70	Bars and rods of copper-zinc base alloys (brass), n.e.s.i., having a rectangular cross section	1.9	Free (A, E, IL, J, CA[2])	2	6
7407.21.90	Bars and rods of copper-zinc base alloys (brass), n.e.s.i., not having a rectangular cross section	2.2	Free (A[3], E, IL, J, CA[2])	34	36
7407.22.10	Profiles of copper-nickel base alloys (cupro-nickel) or copper-nickel-zinc base alloys (nickel silver)	6.3	Free (A, E, IL, J, CA[2])	([4])	([4])
7407.22.50	Bars and rods of copper-nickel base alloys (cupro-nickel) or copper-nickel-zinc base alloys (nickel silver)	6.2	Free (A, E, IL, J, CA[2])	1	1
7407.29.10	Profiles of copper alloys, n.e.s.i	5.2	Free (A, E, IL, J); 3.1% (CA)	5	([4])
7407.29.50	Bars and rods of copper alloys, n.e.s.i	1.6	Free (A, E, IL, J); 0.9% (CA)	21	7
7408.11.30	Wire of refined copper, with a maximum cross-sectional dimension over 9.5 mm	1	Free (A, E, IL, J); 0.6% (CA)	20	2
7408.11.60	Wire of refined copper, with a maximum cross-sectional dimension over 6 mm but not over 9.5 mm	4	Free (A, E, IL, J); 2.4% (CA)	7	2
7408.19.00	Wire of refined copper of which the maximum cross-sectional dimension does not exceed 6 mm	4	Free (A, E, IL, J); 2.4% (CA)	66	7
7408.21.00	Wire of copper-zinc base alloys (brass)	4	Free (A, E, IL, J); 2.4% (CA)	11	25
7408.22.10	Wire of copper-nickel base alloys (cupro nickel) or copper-nickel-zinc base alloys (nickel silver), coated or plated with metal	4.4	Free (A, E, IL, J); 2.6% (CA)	1	([4])
7408.22.50	Wire of copper-nickel base alloys (cupro nickel) or copper-nickel-zinc base alloys (nickel silver), not coated or plated with metal	4	Free (A, E, IL, J); 2.4% (CA)	([4])	4
7408.29.10	Wire of copper alloys n.e.s.i., coated or plated with metal				
7408.29.50	Wire of copper alloys n.e.s.i., not	4.4	Free (A, E, IL, J, CA[2])	21	13
7408.22.50	Wire of copper-nickel base alloys (cupro nickel) or copper-nickel-zinc base alloys (nickel silver), not coated or plated with metal	4	Free (A, E, IL, J); 2.4% (CA)	([4])	4
7408.29.10	Wire of copper alloys n.e.s.i., coated or plated with metal	4.4	Free (A, E, IL, J, CA[2])	21	13
7408.29.50	Wire of copper alloys n.e.s.i., not coated or plated with metal	4	Free (A, E, IL, J, CA[2])	14	6
7409.11.10	Plates, sheets and strip of refined copper, in coils, of a thickness of 5 mm or more	6.7	Free (A, E, IL, J) 4% (CA[5])	([4])	([4])
7409.11.50	Plates, sheets and strip of refined copper, in coils, of a thickness of less than 5 mm	1	Free (A, E, IL, J) 0.6% (CA[5])	7	47

See footnotes at end of table.

Table B-2—Continued
Wrought copper: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty as of Jan. 1, 1992		U.S. exports, 1991	U.S. imports, 1991
		General	Special[1]		
		Percent		*Million dollars*	
7409.19.10	Plates, sheets and strip of refined copper, not in coils, of a thickness of 5 mm or more	4.7	Free (A, E, IL, J); 2.8% (CA[5])	7	4
7409.19.50	Plates, sheets and strip of refined copper, not in coils, of a thickness of less than 5 mm, of a width of 500 mm or more	1	Free (A, E, IL, J); 0.6% (CA[5])	4	8
7409.19.90	Plates, sheets and strip of refined copper, not in coils, of a thickness of less than 5 mm, of a width of less than 500 mm	4.7	Free (A, E, IL, J); 2.8% (CA[5])	10	1
7409.21.00	Plates, sheets and strip of copper-zinc base alloys (brass), in coils	1.9	Free (A, E, IL, J); 1.1% (CA[5])	21	57
7409.29.00	Plates, sheets and strip of copper-zinc base alloys (brass), not in coils	1.9	Free (A, E, IL, J); 1.1% (CA[5])	12	13
7409.31.10	Plates, sheets and strip of copper-tin base alloys (bronze) in coils of a thickness of 5 mm or more	5.1	Free (A, E, IL, J); 3% (CA)	([4])	([4])
7409.31.50	Plates, sheets and strip of copper-tin base alloys (bronze) in coils of a thickness of less than 5 mm, of a width of 500 mm or more	1.7	Free (A, E, IL, J); 1% (CA)	1	4
7409.31.90	Plates, sheets and strip of copper-tin base alloys (bronze) in coils of a thickness of less than 5 mm, of a width of less than 500 mm	5.1	Free (A, E, IL, J); 3% (CA)	2	4
7409.39.10	Plates, sheets and strip of copper-tin base alloys (bronze) not in coils of a thickness of 5 mm or more	5.1	Free (A, E, IL, J); 3% (CA)	2	([4])
7409.39.50	Plates, sheets and strip of copper-tin base alloys (bronze) not in coils of a thickness of less than 5 mm, of a width of 500 mm or more	1.7	Free (A, E, IL, J); 1% (CA)	1	([4])
7409.39.90	Plates, sheets and strip of copper-tin base alloys (bronze) not in coils of a thickness of less than 5 mm, of a width of less than 500 mm or more	5.1	Free (A, E, IL, J); 3% (CA)	([4])	([4])
7409.40.00	Plates, sheets and strip of copper-nickel base alloys (cupro-nickel) or copper-nickel-zinc base alloys (nickel silver)	6.3	Free (A, E, IL, J, CA[2])	3	5
7409.90.10	Plates, sheets and strip of copper alloys, n.e.s.i., of a thickness of less than 5 mm, of a width of 500 mm or more	5.1	Free (A, E, IL, J, CA[2])	([4])	([4])
7409.90.50	Plates, sheets and strip of copper alloys, n.e.s.i., of a thickness of less than 5 mm, of a width of 500 mm or more	1.7	Free (A, E, IL, J); 1% (CA[5])	4	1
7409.90.90	Plates, sheets and strip of copper alloys, n.e.s.i., of a thickness of less than 5 mm, of a width of less than 500 mm	5.1	Free (A, E, IL, J); 3% (CA[5])	39	3
7410.11.00	Copper foil, of a thickness not exceeding 0.15 mm, not backed, of refined copper	1	Free (A, E, IL, J); 0.6% (CA[5])	15	100
7410.12.00	Copper foil, of a thickness not exceeding 0.15 mm, not backed, of copper alloys	1	Free (A, E, IL, J); 0.6% (CA)	3	41
7410.21.30	Copper-clad laminates of refined copper, backed, of a thickness not exceeding 0.15 mm	5.3	Free (A, E, IL, J, CA[2])	49	21
7410.21.60	Copper foil, of a thickness not exceeding 0.15 mm, backed, of refined copper	1.5	Free (A, E, IL, J, CA[2])	2	([4])

See footnotes at end of table.

Table B-2—Continued
Wrought copper: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty as of Jan. 1, 1992		U.S. exports, 1991	U.S. imports, 1991
		General	Special[1]		
		Percent		*Million dollars*	
7410.22.00	Copper foil, of a thickness not exceeding 0.15 mm, backed, of copper alloys	1.5	Free (A, E, IL, J, CA[2])	2	1
7411.10.10	Tubes and pipes of refined copper, seamless	1.5	Free (A, E, IL, J); 0.9% (CA)	57	50
7411.10.50	Tubes and pipes of refined copper, other than seamless	5	Free (A, E, IL, J); 3% (CA)	13	1
7411.21.10	Tubes and pipes of copper-zinc base alloys (brass), seamless	1.4	Free (A, E, IL, J); 0.8% (CA)	12	64
7411.21.50	Tubes and pipes of copper-zinc base alloys (brass), other than seamless	4.5	Free (A, E, IL, J); 2.7% (CA)	3	2
7411.22.00	Tubes and pipes of copper-nickel base alloys (cupro-nickel) or copper-nickel-zinc base alloys (nickel-silver)	5.1	Free (A, E, IL, J); 3% (CA)	1	27
7411.29.10	Tubes and pipes of copper alloys n.e.s.i., seamless	1.4	Free (A, E, IL, J); 0.8% (CA)	4	10
7411.29.50	Tubes and pipes of copper alloys, n.e.s.i., other than seamless	4.5	Free (A, E, IL, J); 2.7% (CA)	7	1
7412.10.00	Tube or pipe fittings of refined copper	11.2	Free (A, B, E, IL, J); 6.7% (CA)	26	([4])
7412.20.00	Tube or pipe fittings of copper alloys	3.2	Free (A, B, E, IL, J); 1.9% (CA[6])	69	26
7419.91.00	Articles of copper, n.e.s.i., cast, molded, stamped, or forged but not further worked	5	Free (A, B, E, IL, J); 3% (CA[6])	24	11
7419.99.15	Containers of copper, of a kind normally carried on the person, in the pocket, or in the handbag	7.8	Free (E, IL, J); 4.6% (CA)	([4])	3
7419.99.30	Articles of copper, n.e.s.i., coated or plated with precious metal	10	Free (A, E, IL); 5.1% (CA[6])	12	3
7419.99.50	Articles of copper, n.e.s.i., not coated or plated with precious metal	5	Free (A, B, E, IL, J); 3% (CA[6])	19	100
	Total and weighted average, all wrought products	[7]2.0		680	775

[1] Programs under which special tariff treatment may be provided and the corresponding symbols for such programs as they are indicated in the "Special" subcolumn, are as follows: Generalized System of Preferences (A); Automotive Products Trade Act (B); Agreement on Trade in Civil Aircraft (C); United States-Canada Free-Trade Agreement (CA); Caribbean Basin Economic Recovery Act (E); United States-Israel Free Trade Area (IL); and Andean Trade Preference Act (J).
[2] Duty with Canada reduced to zero under the accelerated duty reduction provisions of the U.S.-Canada FTA.
[3] Brazil been proclaimed by the President as noneligible for GSP treatment for articles included under this HTS subheading.
[4] Less than $500,000.
[5] Duties on certain articles in this subheading imported from Canada are suspended.
[6] Equipment, originating in the territory of Canada, intended for use in the repair or maintenance of certain motor vehicles subject to accelerated staged tariff reductions.
[7] Average duty rate weighted by value of 1991 imports.

Note.—Because of rounding, figures may not add to the totals shown.

Source: U.S. exports and imports compiled from data of the U.S. Department of Commerce.

Table B–3
Copper ores and concentrates: U.S. imports for consumption, by principal sources, 1986-91

Source	1986	1987	1988	1989	1990	1991
	Quantity (*1,000 kilograms copper content)*					
Mexico	0	0	953	40,939	124,917	46,300
Indonesia	0	0	0	0	0	10,872
Portugal	0	0	0	0	15,840	3,434
Chile	3	0	0	3,566	0	28
Papua New Guinea	0	0	1,823	0	0	1
Canada	1,172	2,339	0	0	0	0
Peru	1,135	0	0	0	60	0
Australia	1,018	0	0	0	0	0
All other	594	0	0	669	0	2
Total	3,922	2,339	2,776	45,171	140,816	60,637
	Value *(1,000 dollars)*					
Mexico	0	0	3,026	40,970	126,792	54,238
Indonesia	0	0	0	0	0	7,903
Portugal	0	0	0	0	6,790	4,509
Chile	2	0	0	8,283	0	8
Papua New Guinea	0	0	10,954	0	0	5
Canada	862	2,031	0	0	0	0
Peru	673	0	0	0	136	0
Australia	641	0	0	0	0	0
All other	287	0	0	4,052	0	4
Total	2,465	2,031	13,980	53,305	133,718	66,666
	Unit value *(dollars per kilogram copper content)*					
Mexico	0	0	3.18	1.00	1.02	1.17
Indonesia	0	0	0	0	0	0.73
Portugal	0	0	0	0	0.43	1.31
Chile	0.67	0	0	2.32	0	0.29
Papua New Guinea	0	0	6.01	0	0	5.00
Canada	0.74	0.87	0	0	0	0
Peru	0.59	0	0	0	2.27	0
Australia	0.63	0	0	0	0	0
All other	0.48	0	0	6.06	0	2.00
Average	0.63	0.87	5.04	1.18	0.95	1.10

Note.—Data before 1989 are estimated. Quantity figures in these import and export tables are gross weight unless otherwise indicated.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-4
Refined copper: U.S. imports for consumption, by principal sources, 1986-91

Source	1986	1987	1988	1989	1990	1991
			Quantity *(1,000 kilograms)*			
Canada	199,232	208,161	177,807	180,813	184,315	197,923
Chile	167,857	125,919	82,747	75,437	56,546	49,814
Brazil	8	0	1,197	18,220	10,203	25,008
Japan	0	599	([1])	3	([1])	4,497
Netherlands	53	6,390	5,050	2,431	0	3,668
Peru	45,535	34,387	13,470	9,241	2,425	5,327
Spain	0	0	3,203	0	220	1,005
Sweden	0	15,230	3,771	0	1,001	778
Germany	0	23,962	5,055	281	145	273
Australia	0	0	125	0	0	66
All other	89,308	54,519	40,653	13,684	6,817	227
Total	501,993	469,167	333,078	300,110	261,672	288,586
			Value *(1,000 dollars)*			
Canada	274,623	338,324	440,755	508,425	475,662	463,893
Chile	222,293	196,851	203,969	215,089	138,818	112,518
Brazil	17	0	2,353	50,691	25,295	57,096
Japan	0	819	3	120	20	12,301
Netherlands	63	12,104	12,342	8,432	0	11,926
Peru	60,155	44,875	32,190	24,865	6,338	11,781
Spain	0	0	9,978	0	282	2,300
Sweden	0	21,460	11,158	0	2,489	1,782
Germany	0	42,434	11,253	1,065	649	689
Australia	0	0	335	0	0	471
All other	119,859	77,780	88,893	37,922	16,420	556
Total	677,010	734,647	813,229	846,609	665,973	675,313
			Unit value *(dollars per kilogram)*			
Canada	1.38	1.63	2.48	2.81	2.58	2.34
Chile	1.32	1.56	2.46	2.85	2.45	2.26
Brazil	2.13	0	1.97	2.78	2.48	2.28
Japan	0	1.37	7.44	38.51	46.46	2.74
Netherlands	1.19	1.89	2.44	3.47	0	3.25
Peru	1.32	1.31	2.39	2.69	2.61	2.21
Spain	0	0	3.12	0	1.28	2.29
Sweden	0	1.41	2.96	0	2.49	2.29
Germany	0	1.77	2.23	3.79	4.47	2.52
Australia	0	0	2.68	0	0	7.12
All other	1.34	1.43	2.19	2.77	2.41	2.45
Average	1.35	1.57	2.44	2.82	2.55	2.34

[1] Less than 500 kilograms.

Note.—Data before 1989 are estimated. East Germany included in “Germany.”

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-5
Copper and copper alloy waste and scrap: U.S. imports for consumption, by principal sources, 1986-91

Source	1986	1987	1988	1989	1990	1991
	Quantity *(1,000 kilograms)*					
Canada	46,114	55,304	54,413	58,123	86,233	74,418
Mexico	61,380	15,839	20,154	24,275	25,903	30,456
Venezuela	1	189	1,513	6,732	5,965	4,829
Dominican Republic	539	958	1,461	1,535	1,497	1,717
Chile	71	105	1,879	8,152	3,844	1,045
France	54	44	180	187	202	319
Colombia	0	0	0	0	2,417	2,050
United Kingdom	96	313	301	275	178	912
Panama	1,006	1,102	1,557	1,486	1,319	1,356
Peru	0	361	130	0	59	545
All other	2,379	3,070	5,592	10,132	6,998	8,269
Total	111,640	77,285	87,180	110,897	134,615	125,916
	Value *(1,000 dollars)*					
Canada	52,015	71,749	115,984	136,884	182,552	134,308
Mexico	15,349	17,300	23,484	38,145	42,576	45,123
Venezuela	6	396	2,342	12,307	11,284	7,097
Dominican Republic	566	1,123	2,605	3,507	3,417	3,024
Chile	88	111	5,267	23,966	8,847	2,500
France	90	187	2,050	1,005	1,528	2,372
Colombia	0	0	0	0	3,488	2,331
United Kingdom	98	653	755	748	451	2,071
Panama	875	1,020	2,233	2,648	2,267	2,029
Peru	0	826	150	0	129	948
All other	2,810	3,458	8,969	16,719	12,534	10,298
Total	71,897	96,823	163,839	235,929	269,073	212,101
	Unit value *(dollars per kilogram)*					
Canada	1.13	1.30	2.13	2.36	2.12	1.80
Mexico	0.25	1.09	1.17	1.57	1.64	1.48
Venezuela	4.74	2.10	1.55	1.83	1.89	1.47
Dominican Republic	1.05	1.17	1.78	2.29	2.28	1.76
Chile	1.24	1.06	2.80	2.94	2.30	2.39
France	1.67	4.25	11.38	5.37	7.56	7.44
Colombia	0	0	0	0	1.44	1.14
United Kingdom	1.02	2.09	2.51	2.72	2.53	2.27
Panama	0.87	0.93	1.43	1.78	1.72	1.50
Peru	0	2.29	1.15	0	2.17	1.74
All other	1.18	1.13	1.60	1.65	1.79	1.25
Average	0.64	1.25	1.88	2.13	2.00	1.68

Note.—Data before 1989 are estimated.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-6
Copper and copper alloy bars, rods, and profiles: U.S. imports for consumption, by principal sources, 1986-91

Source	1986	1987	1988	1989	1990	1991
			Quantity (1,000 kilograms)			
Canada	8,633	10,931	10,820	7,834	4,273	5,275
Japan	695	933	1,123	700	3,827	3,064
Brazil	8,511	4,710	7,061	6,922	6,419	5,469
Germany	2,404	2,455	3,201	2,556	3,054	2,691
France	3,457	3,972	3,204	2,245	2,529	2,352
Poland	56	1,432	2,243	3,309	3,690	2,336
United Kingdom	859	815	747	732	925	625
Norway	0	0	0	506	431	424
Australia	521	436	500	491	744	1,182
Netherlands	96	771	1,710	1,248	938	1,107
All other	16,955	18,287	19,133	25,754	15,033	7,027
Total	42,187	44,742	49,742	52,297	41,863	31,552
			Value *(1,000 dollars)*			
Canada	16,939	22,883	29,563	27,638	15,634	19,658
Japan	2,155	2,859	3,878	3,036	17,455	13,047
Brazil	13,094	7,452	13,914	15,987	15,234	12,236
Germany	6,022	6,835	11,466	10,455	12,351	11,365
France	6,149	8,220	7,208	5,986	7,251	6,119
Poland	64	1,913	3,585	6,850	8,227	5,048
United Kingdom	2,995	3,612	3,315	4,467	5,842	3,763
Norway	0	0	0	4,385	3,752	3,742
Australia	1,192	1,039	1,672	1,921	2,767	3,333
Netherlands	168	1,285	3,830	3,622	2,868	3,100
All other	25,779	29,844	45,886	69,602	40,101	19,072
Total	74,557	85,942	124,317	153,949	131,482	100,483
			Unit value *(dollars per kilogram)*			
Canada	1.96	2.09	2.73	3.53	3.66	3.73
Japan	3.10	3.06	3.45	4.34	4.56	4.26
Brazil	1.54	1.58	1.97	2.31	2.37	2.24
Germany	2.51	2.78	3.58	4.09	4.04	4.22
France	1.78	2.07	2.25	2.67	2.87	2.60
Poland	1.14	1.34	1.60	2.07	2.23	2.16
United Kingdom	3.49	4.43	4.44	6.10	6.32	6.02
Norway	0	0	0	8.67	8.70	8.83
Australia	2.21	2.38	6.63	3.91	3.72	2.82
Netherlands	1.75	1.35	2.24	2.90	3.06	2.80
All other	1.52	1.63	2.40	2.70	2.67	2.71
Average	1.77	1.92	2.50	2.94	3.14	3.18

Note.—Data before 1989 are estimated. East Germany included in “Germany.”

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-7
Copper and copper alloy plates, sheets, and strip: U.S. imports for consumption, by principal sources, 1986-91

Source	1986	1987	1988	1989	1990	1991
			Quantity *(1,000 kilograms)*			
Germany	26,490	17,340	17,010	13,310	11,490	9,740
Japan	13,910	13,000	4,410	3,810	4,470	4,788
Canada	4,560	7,310	8,800	9,020	3,370	4,717
Sweden	3,670	2,330	4,050	4,070	3,330	3,806
Finland	1,340	1,440	2,360	3,420	3,320	3,106
Mexico	640	890	3,850	540	2,770	3,380
Switzerland	2,940	2,970	3,200	3,080	2,400	2,965
Hungary	860	1,680	1,180	1,980	2,220	2,298
Poland	0	9	221	18	632	1,832
Chile	1,440	1,820	2,020	1,690	2,510	1,722
All other	28,440	17,641	17,299	13,082	13,398	5,348
Total	84,290	66,430	64,400	54,020	49,910	43,702
			Value *(1,000 dollars)*			
Germany	56,461	41,638	54,032	52,254	43,765	37,039
Japan	31,878	34,509	19,266	18,296	18,738	18,951
Canada	10,838	18,559	28,632	33,321	12,521	15,066
Sweden	8,821	5,913	12,607	14,592	11,798	13,145
Finland	2,955	3,540	7,920	12,996	12,702	11,773
Mexico	1,104	1,513	8,405	1,760	9,650	10,481
Switzerland	5,013	5,542	6,553	8,355	6,865	7,677
Hungray	1,406	3,069	3,097	6,283	6,500	6,205
Poland	0	16	467	41	1,924	4,970
Chile	2,657	3,687	5,775	5,673	7,473	4,968
All other	55,534	37,627	48,440	44,457	44,714	17,188
Total	176,667	155,613	195,194	198,028	176,650	147,463
			Unit value *(dollars per kilogram)*			
Germany	2.13	2.40	3.18	3.93	3.91	3.80
Japan	2.29	2.65	4.37	4.80	4.19	3.96
Canada	2.38	2.54	3.25	3.69	3.72	3.19
Sweden	2.40	2.54	3.11	3.59	3.54	3.45
Finland	2.21	2.46	3.36	3.80	3.83	3.79
Mexico	1.73	1.70	2.18	3.26	3.48	3.10
Switzerland	1.71	1.87	2.05	2.71	2.86	2.59
Hungary	1.63	1.83	2.62	3.17	2.93	2.70
Poland	0	1.78	2.11	2.28	3.04	2.71
Chile	1.85	2.03	2.86	3.36	2.98	2.89
All Others	1.95	2.13	2.80	3.40	3.34	3.21
Average	2.10	2.34	3.03	3.67	3.54	3.37

Note.—Data before 1989 are estimated. East Germany included in “Germany.”

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-8
Copper and copper alloy tubes and pipes: U.S. imports for consumption, by principal sources, 1986-91

Source	1986	1987	1988	1989	1990	1991
			Quantity *(1,000 kilograms)*			
Germany	13,678	12,193	11,114	10,588	10,286	8,967
Canada	7,751	8,094	7,686	7,501	6,263	7,447
Mexico	7,163	13,601	15,934	14,447	11,499	7,096
Japan	29,334	30,029	24,155	20,053	10,398	6,463
France	467	450	195	865	1,493	2,121
United Kingdom	1,102	643	782	1,307	1,406	750
Chile	546	440	930	1,144	895	799
Yugoslavia	717	649	705	707	679	650
Switzerland	63	129	37	89	172	87
Brazil	891	339	1,921	356	312	421
All other	5,417	6,195	6,367	6,345	3,770	1,500
Total	67,129	72,762	69,826	63,402	47,173	36,301
			Value *(1,000 dollars)*			
Germany	41,561	39,283	42,260	45,885	46,094	37,886
Canada	18,855	23,038	32,687	35,992	27,489	33,530
Mexico	12,955	29,207	50,050	54,805	42,160	26,555
Japan	71,407	78,464	91,148	92,925	43,947	26,118
France	1,121	1,329	761	3,561	6,457	8,116
United Kingdom	5,433	3,537	5,990	9,942	11,518	7,687
Chile	1,088	1,069	2,822	4,155	2,831	2,395
Yugoslavia	1,427	1,304	1,978	2,591	2,475	2,243
Switzerland	1,303	1,694	1,541	1,476	1,751	1,426
Brazil	1,926	766	3,639	1,372	1,138	1,389
All other	12,840	15,442	22,675	23,563	14,000	6,154
Total	169,916	195,133	255,551	276,267	199,860	153,499
			Unit value *(dollars per kilogram)*			
Germany	3.05	3.22	3.80	4.33	4.48	4.23
Canada	2.43	2.85	4.25	4.80	4.39	4.50
Mexico	1.81	2.15	3.14	3.79	3.67	3.74
Japan	2.43	2.61	3.77	4.63	4.23	4.04
France	2.40	2.95	3.89	4.12	4.32	3.83
United Kingdom	4.93	5.50	7.66	7.61	8.19	10.25
Chile	1.99	2.43	3.03	3.63	3.16	3.00
Yugoslavia	1.99	2.01	2.80	3.66	3.65	3.45
Switzerland	20.68	13.13	41.65	16.53	10.19	16.42
Brazil	2.16	2.26	1.89	3.85	3.64	3.30
All other	2.37	2.49	3.56	3.71	3.71	4.10
Average	2.53	2.68	3.66	4.36	4.24	4.23

Note.—Data before 1989 are estimated. East Germany included in “Germany.”

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-9
Copper ores and concentrates: U.S. exports of domestic merchandise, by principal markets, 1986-91

Market	1986	1987	1988	1989	1990	1991
	Quantity *(1,000 kilograms copper content)*					
Japan	131,637	99,553	131,221	214,662	170,009	74,854
Canada	6,345	1,826	5,582	10,999	18,272	40,029
Brazil	0	0	0	40,507	14,220	36,624
China	12,493	2,470	9,358	3,654	17,725	38,363
Philippines	0	0	3,185	7,249	2,802	29,447
South Korea	14,105	5,154	2,688	38,611	18,819	11,458
Bulgaria	0	0	0	4,560	0	5,889
Finland	4,623	7,228	1,784	7,241	4,047	7,045
Taiwan	4,994	3,776	2,986	8,712	59	2,701
Spain	0	4	35	15	28	2,773
All other	153	4,740	35,567	24,251	12,254	3,446
Total	174,350	124,751	192,406	360,461	258,235	252,629
	Value *(1,000 dollars)*					
Japan	141,291	122,124	256,287	347,781	263,477	125,024
Canada	10,288	5,244	8,358	18,543	30,200	75,282
Brazil	0	0	0	42,367	31,834	60,449
China	11,898	2,094	19,271	8,016	49,773	35,534
Philippines	0	0	10,533	7,126	8,040	27,682
South Korea	15,165	9,324	5,149	48,581	49,819	23,449
Bulgaria	0	0	0	9,350	0	13,463
Finland	4,337	7,755	2,296	10,933	6,624	6,872
Taiwan	4,642	5,033	9,853	21,340	124	6,347
Spain	0	7	65	18	55	5,546
All other	205	5,430	67,709	56,893	6,508	2,623
Total	187,826	157,011	379,521	570,948	446,454	382,271
	Unit value *(dollars per kilogram copper content)*					
Japan	1.08	1.23	1.96	1.62	1.55	1.67
Canada	1.63	2.87	1.50	1.69	1.65	1.88
Brazil	0	0	0	1.05	2.24	1.65
China	0.95	0.84	2.05	2.19	2.81	0.93
Philippines	0	0	3.31	0.98	2.87	0.94
South Korea	1.08	1.81	1.92	1.26	2.65	2.05
Bulgaria	0	0	0	2.05	0	2.29
Finland	0.95	1.08	1.28	1.51	1.64	0.98
Taiwan	0.93	1.33	3.30	2.45	2.10	2.35
Spain	0	1.75	1.86	1.20	1.96	2.00
All other	1.34	1.15	1.90	2.35	0.53	0.76
Average	1.08	1.26	1.96	1.58	1.72	1.51

Note.—Data before 1989 are estimated.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-10
Refined copper: U.S. exports of domestic merchandise, by principal markets, 1986-91

Market	1986	1987	1988	1989	1990	1991
			Quantity *(1,000 kilograms)*			
Japan	1	2,479	13,496	48,575	103,166	130,465
Taiwan	2,247	207	1,611	49,995	66,162	88,853
South Korea	1,250	1,781	6,128	1,492	7,871	12,088
Mexico	218	510	8,536	7,345	5,636	7,220
Thailand	0	0	19	0	2,155	5,027
China	0	0	3,543	12,873	3,549	4,319
Singapore	0	2	1,279	1,204	1,425	3,692
Netherlands	0	20	8,694	663	3,369	3,099
Hong Kong	552	402	537	584	1,435	2,691
Canada	3,694	1,670	3,844	4,731	2,028	1,883
All other	4,491	2,125	10,895	6,249	14,368	11,359
Total	12,453	9,196	58,582	133,711	211,164	270,696
			Value *(1,000 dollars)*			
Japan	1	6,033	34,459	120,506	270,913	296,378
Taiwan	2,361	297	2,987	96,070	176,298	205,903
South Korea	940	4,221	14,331	2,871	21,410	28,563
Mexico	246	680	20,041	20,041	15,316	16,676
Thailand	0	0	52	0	5,421	12,161
China	0	0	9,098	31,453	8,853	9,669
Singapore	0	3	3,203	3,067	3,558	9,190
Netherlands	0	42	20,882	2,040	7,926	7,128
Hong Kong	1,145	871	1,509	2,084	4,056	6,864
Canada	5,353	2,399	5,885	7,328	6,407	5,500
All other	8,398	4,381	26,012	17,580	34,675	26,346
Total	18,444	18,927	138,459	303,040	554,833	624,378
			Unit value *(dollars per kilogram)*			
Japan	1.00	2.43	2.55	2.48	2.63	2.27
Taiwan	1.05	1.44	1.85	1.92	2.66	2.32
South Korea	0.75	2.37	2.34	1.92	2.72	2.36
Mexico	1.13	1.33	2.35	2.73	2.72	2.31
Thailand	0	0	2.72	0	2.52	2.42
China	0	0	2.57	2.44	2.49	2.24
Singapore	0	1.50	2.50	2.55	2.50	2.49
Netherlands	0	2.09	2.40	3.08	2.35	2.30
Hong Kong	2.07	2.16	2.81	3.57	2.83	2.55
Canada	1.45	1.44	1.53	1.55	3.16	2.92
All other	1.87	2.06	2.39	2.81	2.41	2.32
Average	1.48	2.06	2.36	2.27	2.63	2.31

Note.—Data before 1989 are estimated.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-11
Copper and copper alloy waste and scrap: U.S. exports of domestic merchandise, by principal markets, 1986-91

Market	1986	1987	1988	1989	1990	1991
			Quantity *(1,000 kilograms)*			
Japan	38,242	39,591	33,356	38,981	46,532	66,518
South Korea	26,737	35,754	63,586	61,768	58,496	71,885
Canada	34,273	32,290	52,782	68,061	60,262	48,110
China	443	370	1,467	14,554	22,554	45,582
Taiwan	68,809	83,372	55,889	37,408	19,320	17,140
India	17,276	12,360	15,200	26,646	33,262	13,923
Mexico	6,733	18,000	21,591	22,644	20,939	11,190
Hong Kong	6,478	3,838	1,639	2,560	4,258	12,360
Belgium	0	0	11,528	9,486	6,552	3,519
Germany	13,345	12,054	30,737	53,067	19,639	2,941
All other	75,696	56,188	31,951	32,282	32,585	13,425
Total	288,032	293,817	319,726	367,457	324,399	306,593
			Value *(1,000 dollars)*			
Japan	43,685	54,741	57,175	86,353	106,055	131,272
South Korea	29,407	44,065	109,262	107,609	112,398	120,276
Canada	53,544	54,383	70,924	95,057	83,582	65,096
China	300	483	1,334	9,414	17,344	32,896
Taiwan	42,705	46,304	48,881	41,747	21,364	21,952
India	17,407	9,739	16,730	34,185	46,199	16,640
Mexico	6,827	26,141	43,990	46,106	41,262	15,603
Hong Kong	2,677	2,282	1,360	2,246	3,454	11,323
Belgium	0	0	12,927	12,381	7,394	9,606
Germany	15,279	14,369	46,844	79,642	29,085	5,302
All other	66,876	49,331	36,066	43,981	52,020	16,397
Total	278,707	301,838	445,493	558,721	520,157	446,363
			Unit value *(dollars per kilogram)*			
Japan	1.14	1.38	1.71	2.22	2.28	1.97
South Korea	1.10	1.23	1.72	1.74	1.92	1.67
Canada	1.56	1.68	1.34	1.40	1.39	1.35
China	0.68	1.30	0.91	0.65	0.77	0.72
Taiwan	0.62	0.56	0.87	1.12	1.11	1.28
India	1.01	0.79	1.10	1.28	1.39	1.20
Mexico	1.01	1.45	2.04	2.04	1.97	1.39
Hong Kong	0.41	0.59	0.83	0.88	0.81	0.92
Belgium	0	0	1.12	1.31	1.13	2.73
Germany	1.14	1.19	1.52	1.50	1.48	1.80
All other	0.88	0.88	1.13	1.36	1.60	1.22
Average	0.97	1.03	1.39	1.52	1.60	1.46

Note.—Data before 1989 are estimated. East Germany included in “Germany.”

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-12
Copper and copper alloy bars, rods, and profiles: U.S. exports of domestic merchandise, by principal markets, 1986-91

Market	1986	1987	1988	1989	1990	1991
			Quantity *(1,000 kilograms)*			
Canada	7,239	8,884	13,592	16,464	20,445	19,225
Mexico	442	1,758	1,109	6,755	3,166	3,728
Japan	51	114	517	1,877	444	637
Netherlands	277	405	704	621	605	518
Taiwan	24	43	132	3,117	4,792	1,231
Colombia	3	57	11	119	237	911
Dominican Republic	586	474	792	1,186	1,102	854
Hong Kong	12	6	32	44	515	490
Germany	125	91	114	110	178	175
France	165	86	151	324	81	117
All other	2,574	4,079	3,441	11,443	5,637	3,206
Total	11,498	15,997	20,595	42,060	37,202	31,092
			Value *(1,000 dollars)*			
Canada	14,052	20,266	33,094	49,938	61,018	53,307
Mexico	1,304	4,306	3,476	22,866	9,905	8,538
Japan	609	1,556	2,609	7,099	4,411	4,047
Netherlands	1,547	2,434	3,545	3,765	3,514	3,343
Taiwan	163	242	777	8,202	12,182	3,063
Colombia	12	117	22	566	734	2,383
Dominican Republic	920	900	2,010	3,902	2,758	2,265
Hong Kong	71	30	158	488	1,969	2,180
Germany	1,847	1,611	2,186	1,952	3,040	2,156
France	2,387	1,544	1,268	2,107	787	2,138
All other	7,750	11,415	13,340	37,159	20,588	13,445
Total	30,662	44,421	62,485	138,044	120,906	96,865
			Unit value *(dollars per kilogram)*			
Canada	1.94	2.28	2.43	3.03	2.98	2.77
Mexico	2.95	2.45	3.13	3.39	3.13	2.29
Japan	11.94	13.65	5.05	3.78	9.94	6.35
Netherlands	5.59	6.01	5.04	6.06	5.80	6.45
Taiwan	6.79	5.63	5.88	2.63	2.54	2.49
Colombia	4.02	2.06	1.95	4.76	3.09	2.62
Dominican Republic	1.57	1.90	2.54	3.29	2.50	2.65
Hong Kong	5.85	4.79	4.92	11.21	3.82	4.45
Germany	14.78	17.70	19.18	17.75	17.06	12.29
France	14.49	18.00	8.38	6.51	9.78	18.20
All other	3.01	2.80	3.88	3.25	3.65	4.19
Average	2.67	2.78	3.03	3.28	3.25	3.12

Note.—Data before 1989 are estimated. East Germany included in “Germany.”

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-13
Copper and copper alloy plates, sheets, and strip: U.S. exports of domestic merchandise, by principal markets, 1986-91

Market	1986	1987	1988	1989	1990	1991
			Quantity *(1,000 kilograms)*			
Canada	1,836	1,510	1,760	2,720	10,209	9,831
Germany	437	558	560	636	1,019	988
Mexico	655	990	8,668	1,283	1,394	2,363
France	697	798	886	963	757	795
Japan	409	1,194	1,648	1,235	796	979
Taiwan	121	287	94	993	1,353	863
Malaysia	552	958	780	944	1,327	764
Singapore	145	370	272	291	339	507
United Kingdom	203	256	474	413	616	196
Switzerland	135	255	201	140	116	169
All other	612	1,010	1,182	2,189	3,730	3,082
Total	5,802	8,186	16,525	11,807	21,656	20,537
			Value *(1,000 dollars)*			
Canada	8,890	10,482	13,950	19,528	39,002	35,373
Germany	5,693	8,564	10,431	8,888	14,696	13,124
Mexico	4,081	4,663	34,329	6,446	7,993	12,088
France	6,812	9,883	10,970	10,610	10,238	9,710
Japan	2,358	6,695	11,069	8,888	7,739	7,710
Taiwan	501	1,206	801	4,818	11,282	6,137
Malaysia	2,343	4,223	4,485	5,377	7,868	4,932
Singapore	1,364	2,298	2,047	1,890	2,593	3,251
United Kingdom	2,579	3,732	6,469	4,727	7,499	3,036
Switzerland	2,037	3,403	3,943	2,411	2,015	2,843
All other	5,486	7,220	9,300	12,893	18,917	15,117
Total	42,144	62,369	107,794	86,476	129,842	113,321
			Unit value *(dollars per kilogram)*			
Canada	4.84	6.94	7.93	7.18	3.82	3.60
Germany	13.01	15.36	18.61	13.97	14.42	13.28
Mexico	6.23	4.71	3.96	5.03	5.73	5.12
France	9.77	12.39	12.38	11.02	13.52	12.21
Japan	5.75	5.61	6.72	7.20	9.72	7.88
Taiwan	4.14	4.20	8.52	4.85	8.34	7.11
Malaysia	4.25	4.41	5.75	5.69	5.93	6.46
Singapore	9.40	6.22	7.52	6.50	7.64	6.41
United Kingdom	12.71	14.58	13.64	11.44	12.18	15.53
Switzerland	15.06	13.36	19.63	17.16	17.36	16.83
All other	8.96	7.15	7.87	5.89	5.07	4.90
Average	7.26	7.62	6.52	7.32	6.00	5.52

Note.—Data before 1989 are estimated. East Germany included in “Germany.”

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-14
Copper and copper alloy tubes and pipes: U.S. exports of domestic merchandise, by principal markets, 1986-91

Market	1986	1987	1988	1989	1990	1991
			Quantity *(1,000 kilograms)*			
Canada	2,767	3,547	3,169	8,676	8,950	10,133
Mexico	2,141	2,628	5,021	5,202	3,262	3,765
Australia	68	114	99	224	76	820
Saudi Arabia	1,252	577	1,534	778	819	1,045
Venezuela	147	595	721	333	264	846
Spain	230	293	406	729	1,053	921
Taiwan	207	126	291	1,002	584	762
Malaysia	12	5	146	463	414	617
Netherlands	348	339	567	619	523	617
United Arab Emirate	144	187	342	343	451	695
All other	2,269	3,906	4,804	6,506	4,666	5,524
Total	9,585	12,317	17,100	24,875	21,062	25,745
			Value *(1,000 dollars)*			
Canada	10,155	13,003	14,241	26,734	37,570	38,863
Mexico	7,964	12,335	26,322	16,509	11,542	13,874
Australia	416	598	1,077	1,275	499	5,159
Saudi Arabia	2,114	1,579	6,024	3,037	3,287	3,717
Venezuela	503	2,200	3,757	1,520	1,051	3,102
Spain	550	787	1,558	2,160	4,489	2,981
Taiwan	431	374	1,317	3,495	2,570	2,928
Malaysia	44	29	498	2,165	1,571	2,333
Netherlands	1,138	1,018	2,207	2,667	1,834	2,247
United Arab Emirate	332	458	1,008	1,239	1,744	2,212
All other	8,136	14,219	19,457	27,920	21,309	19,233
Total	31,783	46,600	77,466	88,721	87,466	96,649
			Unit value *(dollars per kilogram)*			
Canada	3.67	3.67	4.49	3.08	4.20	3.84
Mexico	3.72	4.69	5.24	3.17	3.54	3.68
Australia	6.07	5.22	10.88	5.69	6.60	6.29
Saudi Arabia	1.69	2.73	3.93	3.90	4.01	3.56
Venezuela	3.42	3.69	5.21	4.56	3.99	3.67
Spain	2.39	2.69	3.84	2.97	4.26	3.24
Taiwan	2.08	2.98	4.53	3.49	4.40	3.84
Malaysia	3.67	5.80	3.41	4.68	3.80	3.78
Netherlands	3.27	3.00	3.89	4.31	3.51	3.64
United Arab Emirate	2.31	2.45	2.94	3.61	3.86	3.18
All other	3.59	3.64	4.05	4.29	3.28	3.48
Average	3.32	3.78	4.53	3.57	4.15	3.75

Note.—Data before 1989 are estimated.

Source: Compiled from official statistics of the U.S. Department of Commerce.

APPENDIX C
GLOSSARY

GLOSSARY

Annealing

Heating copper or copper alloy shapes to a suitable temperature to obtain desired mechanical properties. Typically, cold-rolled products must be annealed to soften the metal and aid machinability.

Atomization

Method of producing copper powder by dispersing molten metal into particles using a rapidly moving stream of gas or liquid.

Bars and rods

Products usually made by an extrusion process with a uniform cross-sectional configuration in the shape of circles, ovals, rectangles, equilateral triangles, or regular convex polygons and not in coils. Industry sources indicate bars refer to rectangular cross-sectional shapes and rods refer to round or near-round configurations.

Billet

A cylindrically shaped casting made from molten copper or copper alloy. Typically, billets are used in an extrusion process to make bars, rods, profiles, tubes, and pipes.

Cake

A slab of metal with a rectangular cross-section cast from molten copper or copper alloys. Typically a cake is hot rolled and cold rolled to produce flat products.

Continuously cast wire rod

A shape that is continuously solidified while it is being poured from molten copper. The process of making wire rod involves integral steps of casting and hot rolling the metal from a square to circular cross-sectional configuration, with a final diameter usually of 7.9 millimeters (mm). Wire rod is drawn down to produce copper wire.

Converting

The process of upgrading copper matte by blowing air through the material and oxidizing the impurities, which are then removed as slag.

Drawing

The process of pulling a copper or copper alloy shape through a die to reduce the diameter. Several drawing steps are used to reduce the diameter. Typically, wire and tubes are drawn to reduce the diameter to the final desired dimension.

Electro-deposited foil

A product manufactured by depositing copper out of a solution onto an electrode, which is shaped to form the copper into foil. This method produces a high-purity copper foil and is an alternative to foil production by rolling.

Electrolytic refining

A process in which the copper is transferred through a solution electrically from an anode and plated out as a cathode. The impurities in the anode drop to the bottom of the process tank.

Extruding

A process whereby a metal shape, usually a billet, is expelled through a die that is formed in the desired cross-sectional shape. Typically, an extrusion process is used to produce bars, rods, profiles, tubes, and pipes.

Fire refining

Refining blister copper by oxidizing impurities and removing oxygen.

Flotation

The process of separating copper-containing minerals from waste minerals. The minerals are ground into fine particles, are mixed with water, and are put into a tank. The copper-containing minerals adhere to air bubbles introduced in the tank and float to the surface, where the froth is scrapped off, forming a copper concentrate. Chemical reagents are added to the solution to help the process.

Plates, sheets, strip, and foil

Flat-surfaced products, in coils or not, of solid rectangular cross section of uniform thickness. Plates are 5 mm or thicker, sheets and strip are less than 5 mm thick but greater than 0.15 mm thick, and foil is less than 0.15 mm thick. The generally accepted industry distinction between

sheets and strip is that strip refers to coiled products and sheets refers to uncoiled (i.e., cut-to-length) products.

Profiles

A rolled, extruded, drawn, forged, or cast product, which may be coiled or not, and which includes all products that do not conform to the definitions of bars, rods, wire, plates, sheets, strip, foil, tubes, or pipes.

Rolling

Process of passing a copper or copper alloy shape between steel rollers that deform the shape into a thinner cross-sectional configuration. In hot rolling, external heat is applied to the metal. In cold rolling, no external heat is applied to the metal.

Smelting

A pyrometallurgical process that chemically separates the copper from waste elements, usually iron, sulfur, and oxygen.

Tubes and pipes

Hollow products, coiled or not, with a uniform wall thickness and cross section in the shape of circles, ovals, rectangles, equilateral triangles, or regular convex polygons. The industry makes no distinction between tubes and pipes.

Wire

A solid product of uniform cross-sectional configuration in the shape of circles, ovals, rectangles, equilateral triangles, or regular convex polygons, usually in coils and made by rolling, drawing, or extruding.