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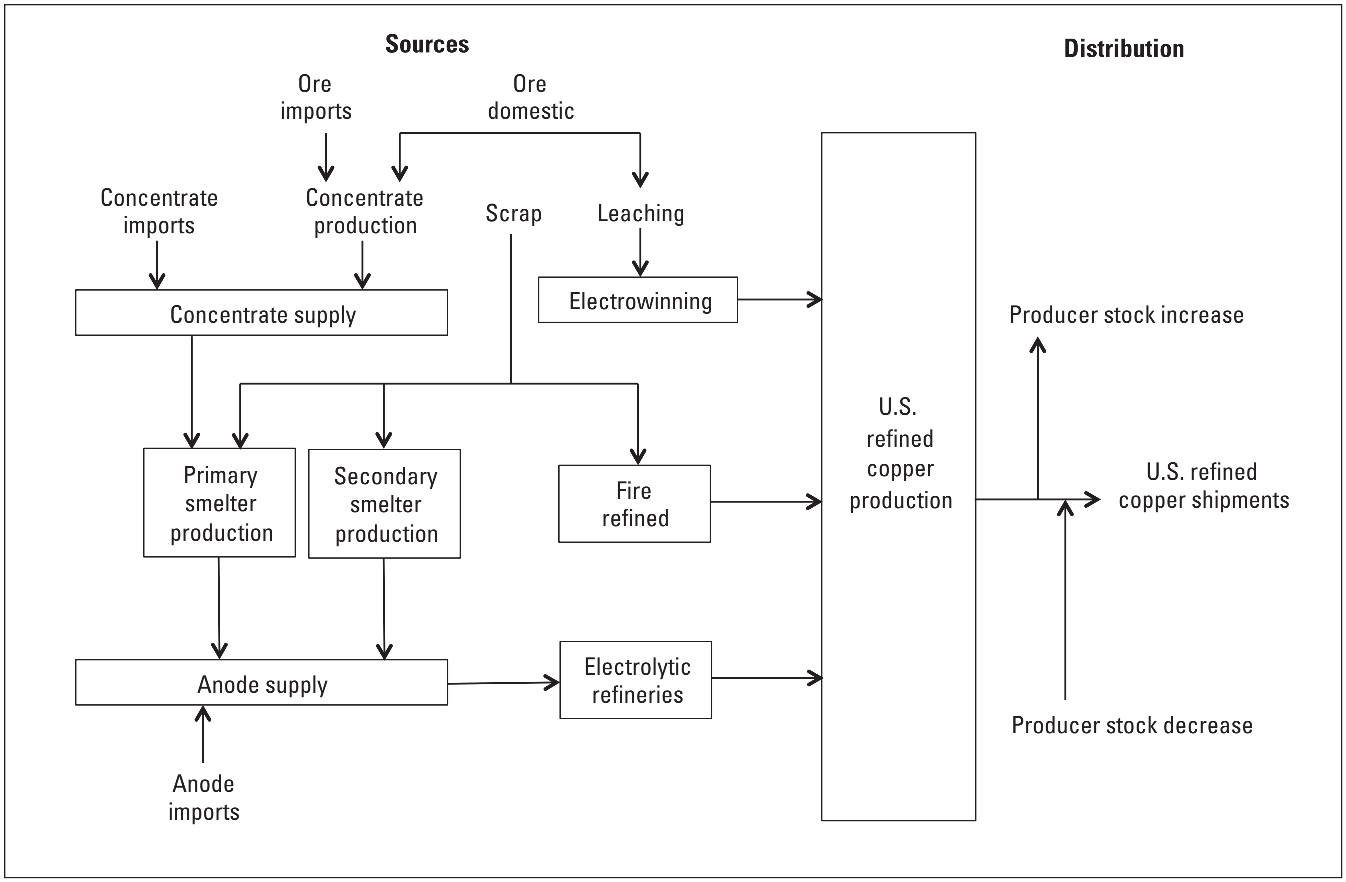
United States Copper Metal and Scrap Use and Trade Patterns, 1995–2014



Scientific Investigations Report 2016–5075

U.S. Department of the Interior
U.S. Geological Survey

Cover. Generalized flow chart showing the sources and distribution of U.S. refined copper production.

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By Thomas G. Goonan

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U.S. Geological Survey
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Conversion Factors

International System of Units to Inch/Pound

Multiply	By	To obtain
kilogram (kg)	2.205	pound avoirdupois (lb)
kilogram (kg)	32.1507	troy ounce
metric ton (t) (1,000 kg)	1.102	short ton (2,000 pounds)
kiloton (kt) (1,000 t)	1,102	short ton (2,000 pounds)

Abbreviation

Mt million metric tons

United States Copper Metal and Scrap Use and Trade Patterns, 1995–2014

By Thomas G. Goonan

Abstract

In 1995, China accounted for 10 percent of world copper consumption (Yue and Lu, 2006; Dove Communications Inc., 2012). By 2014, China accounted for about 49 percent of world copper consumption (World Bureau of Metal Statistics, 2015). This change has affected global copper and copper scrap prices, the sources of copper supply, and U.S. trade of copper-containing materials.

This report considers changes to the copper and copper scrap industries of the United States. For the study period, 1995 through 2014, U.S. refined copper production from all sources (primary and secondary materials) decreased from 2.28 million metric tons (Mt) of copper[1] to 1.05 Mt (a 54 percent decrease). During the same period, U.S. copper scrap net exports increased from 0.203 Mt to 0.737 Mt (a 263 percent increase and a compound annual growth rate of about 7.0 percent per year). Copper and copper scrap prices (in constant 2014 dollars) rose such that 2014 prices were about 48 percent greater than 1995 prices. From 1995 through 2014, Chinese imports of copper scrap from the United States grew from 0.061 Mt to 0.569 Mt (an increase of ~830 percent and a compound annual growth rate of ~12.5 percent per year). In 2011, Chinese imports of U.S. copper scrap peaked at 0.745 Mt of contained copper. In 1995, Chinese imports of U.S. copper scrap accounted for 17 percent of U.S. copper scrap exports. By 2014, Chinese imports accounted for 69 percent of U.S. copper scrap exports (by weight), and Chinese imports of U.S. copper scrap were valued at $1.45 billion.

[1]Unless stated otherwise, all weight units are in terms of contained copper (the copper content of scrap).

Introduction

Copper-containing products include copper metal, copper alloys, and copper chemicals. All of these are manufactured in the United States from primary raw materials supplemented by significant quantities of secondary materials (recycled scrap). Throughout the study period, 1995–2014, the flows of copper-containing materials needed for the manufacture of useful copper-containing products changed. Trends for these changes are reported here. For example, U.S. refined copper production in 2014 was less than half of what it was in 1995. Annual refined copper imports more than doubled (0.429 to 1.06 Mt)[2] from 1995 through 2000 (partly in response to reduced domestic refined copper production), then, on average, remained relatively level (0.962 Mt) through 2006, thereafter declining by about 5 percent per year (compounded annually) to the 2014 level of 0.620 Mt. In terms of percentage, the U.S. share of world refined copper production decreased by a factor of 4 (19 percent to 4.5 percent of world refined copper production over the study period). These salient trends are shown in figure 1.

From 1997 through 2002, the average annual use of old scrap in U.S. refined and alloy copper production decreased by about 72 percent. For the same period, the use of new scrap for the same purpose decreased by about 18 percent. This was a period characterized by closures of both primary smelting and secondary domestic copper production at downstream plants and mills. For the same period, the U.S. export of copper-containing scrap increased by about 35 percent. Compared to the dynamics in scrap use and trade, U.S. copper-containing

[2]All mass units are reported to three significant figures.

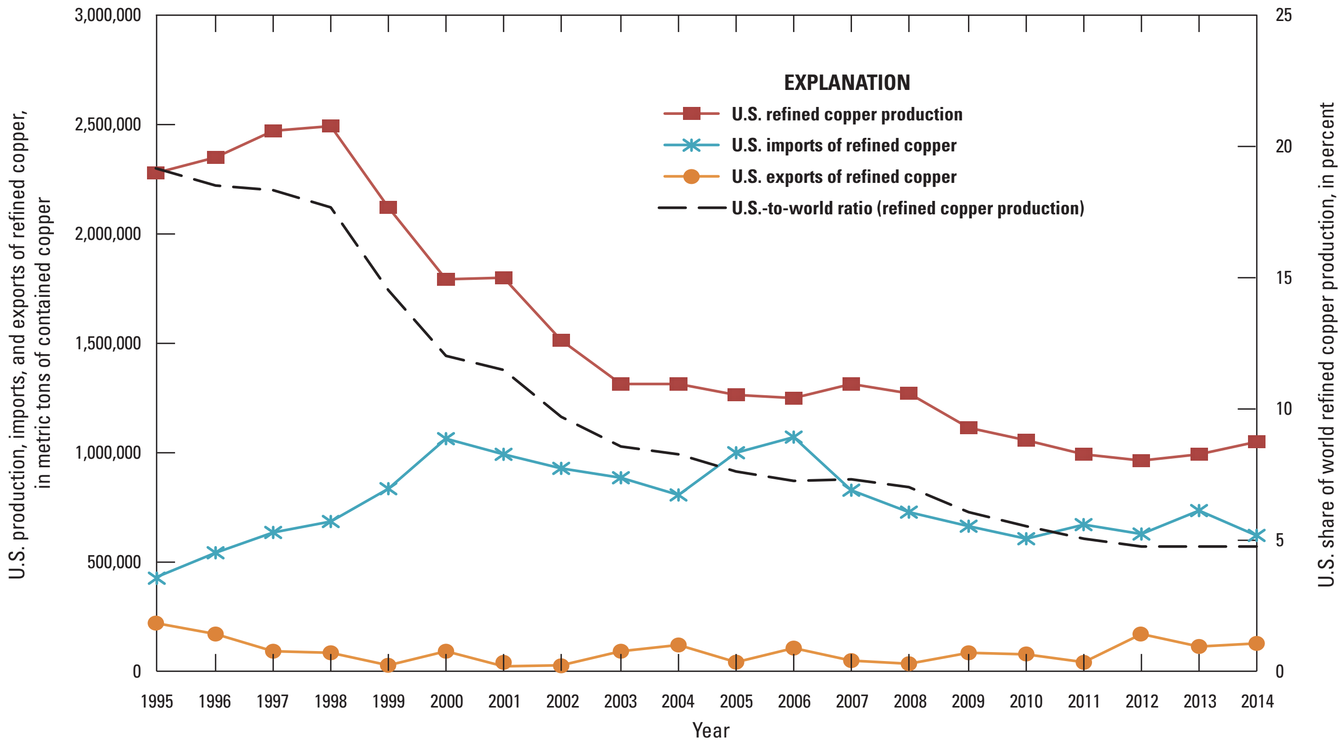

Figure 1. Line chart showing U.S. production, imports, and exports of refined copper, 1995 through 2014. Sources: U.S. Geological Survey (1995–2013); Brininstool (2015a,b); Mark Brininstool, U.S. Geological Survey, unpub. data, 2016.

scrap imports were relatively steady for the entire 1995–2014 study period. The average annual use of new scrap in U.S. production at the primary and secondary level decreased in steps over this study period, as follows: for 1995–2000, the average annual use was 1.02 Mt; for 2003–2007, the average annual use was 0.792 Mt; and for 2009–2014, the average annual use was 0.638 Mt. Since new scrap is basically turn-around material that sustains production levels, the decrease mirrors the reduction in level of production in U.S. plants and mills. These data are shown in figure 2.

U.S. Copper Metal Supply

Refined copper metal, in the form of cathode (99.99 percent pure copper), is produced from domestic ores and imported materials (ores, concentrates, anodes, and other), with minor augmentation by scrap. Refined copper is produced either by electrolysis of anodes (a product of pyrometallurgical smelting) or by electrowinning of copper from copper-bearing solutions (a product of hydro-metallurgical leaching of domestic ores). Fire-refined copper (99.25 percent pure copper) adds a small amount of refined copper to annual supply. The main components of U.S. refined copper production are shown as a generalized flow diagram in figure 3 and annual contributions to U.S. refined copper production are shown for the study period in figure 4.

U.S. annual refined copper metal production has continuously decreased (5.5 percent per year, compounded annually) from its study-period peak-year level, 2.49 Mt in 1998, to 1.01 Mt in 2014, a difference of 1.48 Mt. During the same period, Chinese consumption of refined copper increased (15.8 percent per year, compounded annually) from 1.48 Mt in 1998 to 15.4 Mt in 2014 (Yue and Lu, 2006; China Mining Association, 2012; Dove Communications Inc., 2012; and World Bureau of Metal Statistics, 2015).

In 1998, U.S. electrolytically refined copper production was 1.53 Mt using seven primary (concentrate) smelters and three secondary (scrap) smelters to feed seven electrolytic refineries. In 2003, U.S. electrolytically refined copper production was 0.662 Mt (a 15.4 percent per year decrease, compounded annually), and used the facilities of just three primary (concentrate) smelters to feed four electrolytic refineries. From 1998 through 2003, fire-refined copper production decreased (reflecting closure of three facilities) by 0.110 Mt, and electrowinning copper production decreased by 0.018 Mt.

From 1998 through 2003, total U.S. refined copper production decreased by 1.20 Mt, of which about 76 percent was attributable (by a sequence of reduced production ending in closure) to four primary smelters, 13 percent to three secondary smelters, 10 percent to three fire refineries, and 1 percent to three electrowinning refineries. The 1.20 Mt reduction in U.S. refined copper production was partially offset by increased imports of refined copper (0.199 Mt), for a net loss to U.S. refined copper supply of about 0.939 Mt.

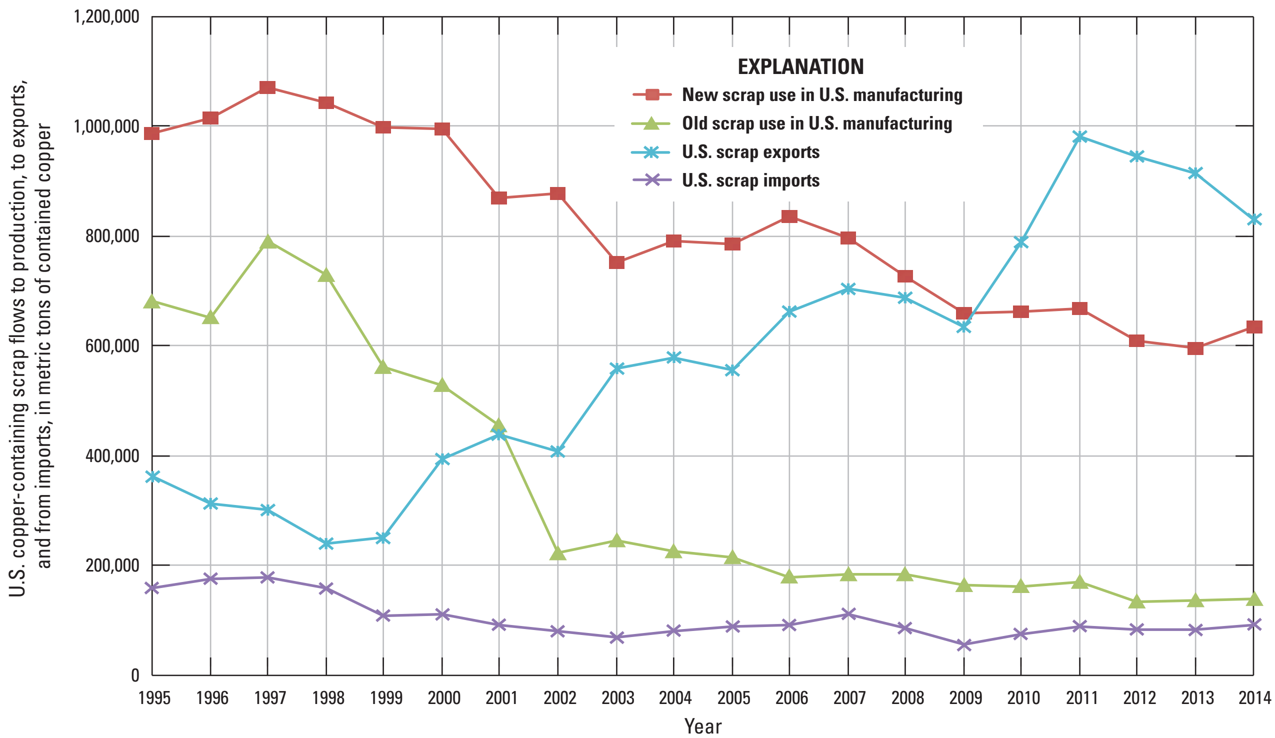

Figure 2. Line chart showing U.S. copper-containing scrap flows to manufacturing (production), to exports, and from imports, 1995 through 2014. Sources: U.S. Geological Survey (1995–2013); Brininstool (2015a,b); Mark Brininstool, U.S. Geological Survey, unpub. data, 2016.

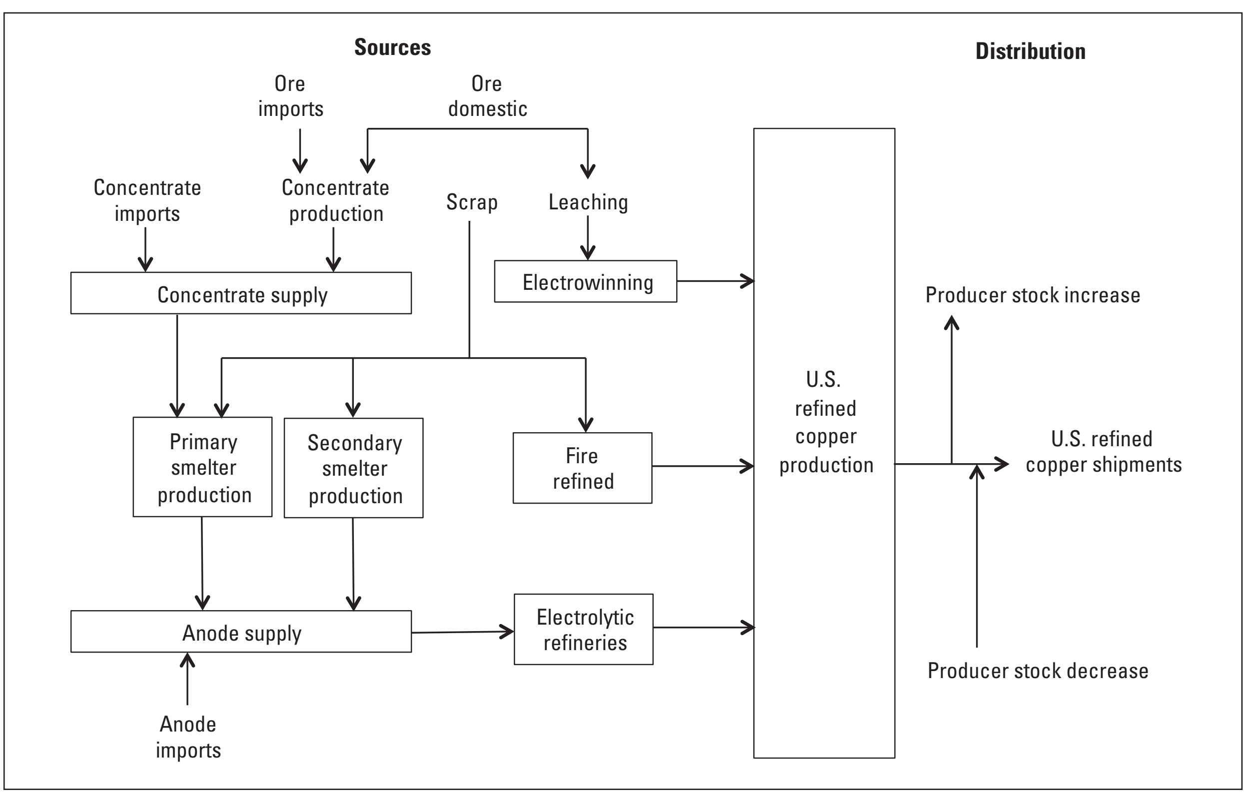

Figure 3. Generalized flow chart showing the sources and distribution of U.S. refined copper production.

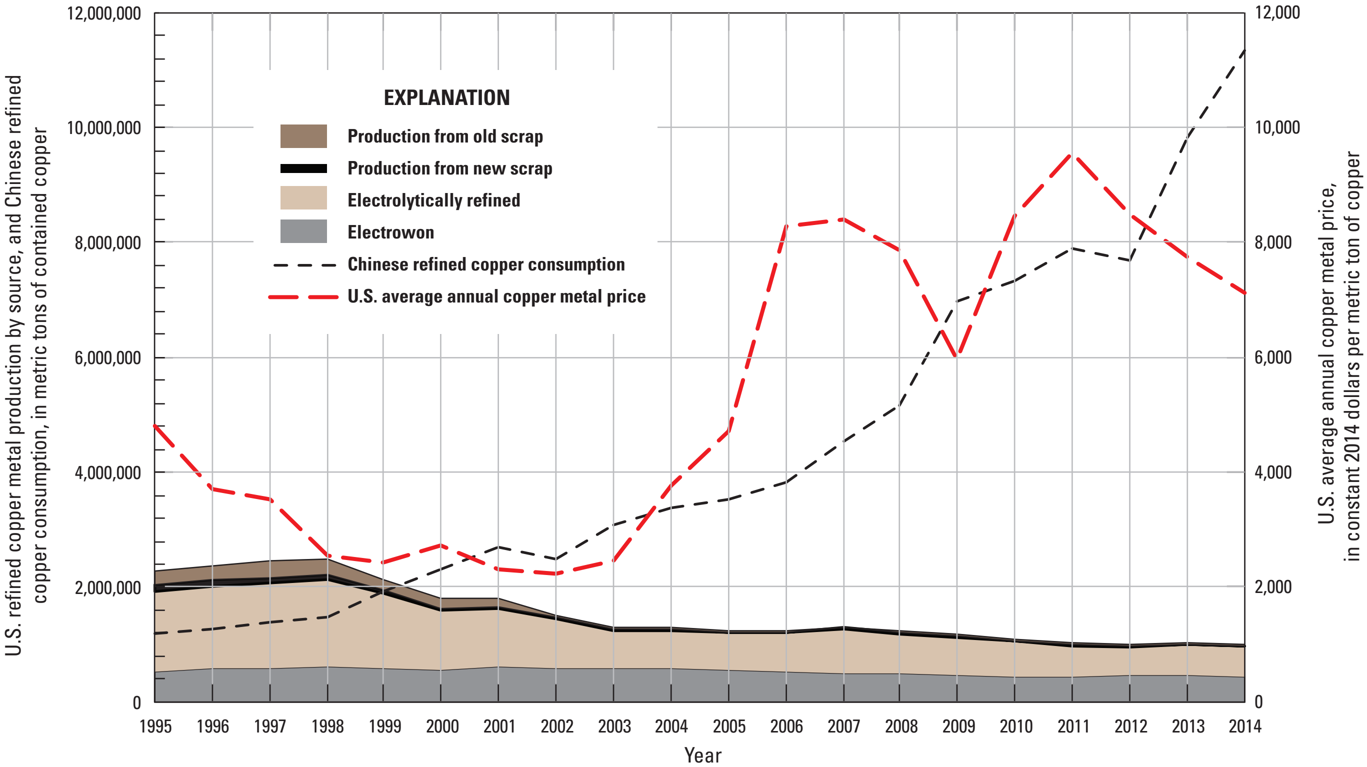

Figure 4. Area and line chart showing U.S. refined copper metal production by source, Chinese refined copper consumption, and U.S. average annual copper metal price, 1995 through 2014. U.S. copper producer prices have been discounted to constant 2014 dollars using the "Historical Consumer Price Index for All Urban Consumers" from the U.S. Department of Labor, Bureau of Labor Statistics (Crawford and others, 2016, p. 72). Other sources: U.S. Geological Survey (1995–2013); Yue and Lu (2006); China Mining Association (2012); Dove Communications Inc. (2012); Brininstool (2015a,b); World Bureau of Metal Statistics (2015); Mark Brininstool, U.S. Geological Survey, unpub. data, 2016.

When supply reduction occurs, it is usually the marginal producers that close. In the U.S. case, lower copper prices and higher production costs associated with lower ore grades, increased energy costs, and pollution control expenses (fines, and capital requirements) were sufficient to force closures (Edelstein, 2002, 2003, 2004, 2005).

From 1998 through 2003, average annual U.S. copper producer prices (in constant 2014 dollars per metric ton) were at their nadir for the study period. From 1998 through 2003, as U.S. refined copper production decreased by 1.20 Mt, Chinese annual consumption of refined copper increased by 1.61 Mt. From 2003 through 2007, copper metal prices rose, driven up by increased refined copper consumption in China as the Chinese economy rapidly expanded. Prices decreased for the period 2007 through 2009, which was attributable to the global economic downturn. Prices then increased sharply through 2011, again declining through 2014.

U.S. Copper Supply for Semi-Manufacturing

U.S. refined copper production (previous section), after adjustment for producer inventory changes, becomes refinery shipments. U.S. semi-manufacturers (brass and wire-rod mills, foundries, and chemical plants) use refined copper, copper-containing scrap, and small amounts of other forms of copper to make their products. The refined copper available to semi-manufacturers includes U.S. refined copper shipments less exports, plus imports, adjusted for changes to the inventories of copper at the U.S. warehouses owned by commodity exchanges (COMEX and LME)[3].

[3]COMEX, Commodity Exchange, Inc., a division of the New York Mercantile Exchange (NYMEX). LME, London Metal Exchange.

The annual U.S. refined copper supply for the study period is shown in table 1.

U.S. brass mills, chemical plants, foundries, wire-rod mills, and miscellaneous facilities use refined copper and old scrap to manufacture shapes (pipes, slabs, rods, wire, castings, and other products) composed of copper and copper alloys. New scrap generated by semi-manufacturers is returned to the process and does not add to supply, but rather sustains output levels. Figure 5 shows these generalized flows.

Changes in the average annual semi-manufacturing copper production, 1995–2014, are shown in figure 6. Total average annual use of refined copper and scrap together in U.S. semi-manufacturing (brass and wire-rod mills, foundries, and other facilities) decreased in steps during the study period as follows: 1995–2000, 3.77 Mt; 2001–2007, 3.14 Mt; and 2008–2014, 2.35 Mt. These reductions in semi-manufactured copper production were the result of reductions in the number of domestic facilities operating, due to higher costs and reduced competitiveness. While the number of wire-rod mills remained relatively constant over the study period (15–16), the number of brass mills decreased from 35 to 30, and the number of foundries and other facilities decreased from 600 to 500.

Average refined copper usage in domestic semi-manufacturing decreased as follows: 1995–2000, 74.2 percent: 2001–2007, 72.7 percent; and 2008–2014, 70.0 percent. The decrease in refined copper usage was offset by increased use of new scrap (indicating better recovery thereof) as follows: 1995–2000, 21.3 percent; 2001–2007, 23.2 percent; and 2008–2014, 25.5 percent. Usage of old scrap for the entire study period remained level at 4.5 percent.

Table 1. Annual U.S. refined copper supply, 1995–2014.

[All values are in million metric tons of contained copper. Values have been rounded to three significant digits. A negative number in the commodity exchange (COMEX and LME) inventory change column indicates an addition to refined copper available to U.S. semi-manufacturers, and a positive number is a subtraction therefrom. Sources: U.S. Geological Survey (1995–2013); Brininstool (2015a,b); Mark Brininstool, U.S. Geological Survey, unpub. data, 2016. Abbreviations: COMEX, Commodity Exchange, Inc. (a division of the New York Mercantile Exchange [NYMEX]); LME, London Metal Exchange]

Year	U.S. refined copper			Sum of COMEX and LME inventory change	Total addition to U.S. refined copper supply	Refined copper available for U.S. semi-manufacturers
	Supply	Imports	Exports			
1995	2.290	0.429	0.217	0.066	0.147	2.440
1996	2.360	0.543	0.169	–0.025	0.399	2.760
1997	2.440	0.632	0.093	0.147	0.392	2.830
1998	2.500	0.068	0.086	0.214	0.383	2.880
1999	2.160	0.837	0.025	0.069	0.743	2.900
2000	1.790	1.060	0.093	–0.232	1.200	2.990
2001	1.790	0.991	0.023	0.598	0.370	2.160
2002	1.530	0.927	0.027	0.102	0.798	2.330
2003	1.310	0.882	0.093	–0.373	1.160	2.470
2004	1.310	0.807	0.118	–0.511	1.200	2.510
2005	1.260	1.000	0.040	–0.072	1.030	2.290
2006	1.230	1.070	0.106	0.100	0.864	2.090
2007	1.320	0.083	0.051	–0.032	0.810	2.130
2008	1.250	0.724	0.037	0.067	0.620	1.870
2009	1.160	0.664	0.081	0.232	0.351	1.510
2010	1.100	0.605	0.076	–0.030	0.560	1.660
2011	1.020	0.670	0.040	0.022	0.607	1.630
2012	0.991	0.630	0.169	–0.181	0.642	1.630
2013	1.040	0.734	0.111	0.016	0.607	1.640
2014	1.020	0.620	0.127	–0.074	0.567	1.580

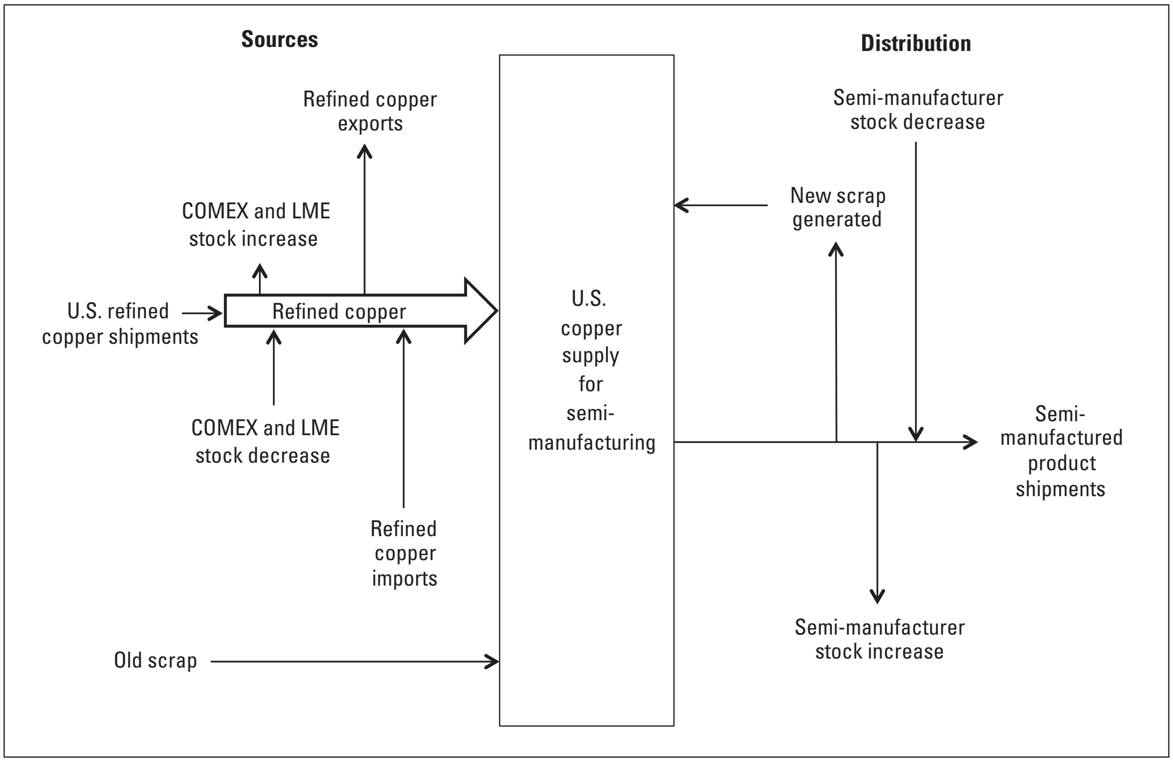

Figure 5. Flow chart showing the sources and distribution of the U.S. copper supply for semi-manufacturing.

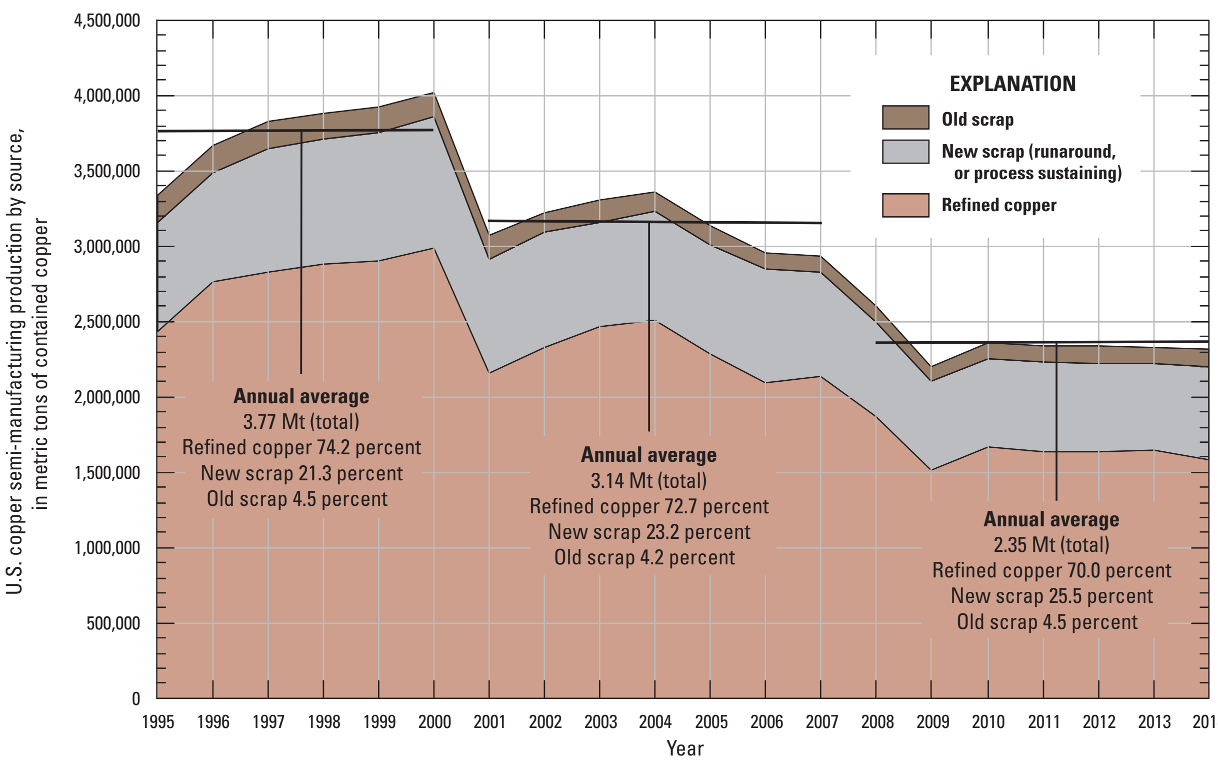

Figure 6. Area and line chart showing U.S. copper semi-manufacturing production by source, 1995 through 2014. Values for annual averages reported within the graphic are in million metric tons (Mt) of contained copper. Sources: U.S. Geological Survey (1995–2013); Brininstool (2015a,b); Mark Brininstool, U.S. Geological Survey, unpub. data, 2016.

U.S. Copper Scrap Trade

In general, scrap trade is dominated by old scrap recovered from post-consumer sources. New scrap is generated and returned to use domestically. The United States is, and has been for the entire study period, a net exporter of old copper scrap. Most U.S. imports of copper scrap are sourced from Canada, Mexico, and Caribbean and South American countries.

U.S. trade in old copper scrap has changed along with the changes in old copper scrap usage in the production of U.S. refined copper and mill products. Figure 7 shows the distribution of U.S. old copper scrap supply among usage in domestic production and trade as net exports, with the U.S. price of copper for context.

Figure 7 shows that old scrap usage for U.S. domestic copper production decreased sharply from 1997 (period peak, 0.790 Mt) through 2002 (0.224 Mt). During this 5-year period, major scrap users either reduced operations or closed (four primary smelters, four secondary smelters, three fire refiners, and five brass mills) under pressure of low prices and high costs (Edelstein, 2002, 2003, 2004, 2005). From 1999 through 2012, scrap suppliers increasingly exported old scrap. Higher copper prices from 2009 through 2012 caused the collection of additional scrap for export, of which a high percentage went to China. With lower prices in 2013 and 2014, less old scrap was collected and exported.

Figure 8 shows the quantities and destinations for U.S. copper scrap exports for the study period. From 1995 through 2014, U.S. copper scrap exports increased from 0.375 to 0.830 Mt of contained copper, a growth rate of 4.3 percent per year, compounded annually. The subtotal of U.S. exports of copper scrap to countries other than China was relatively stable for the study period.

The importance of U.S. exports of copper scrap to China is clearly seen by the placement of the China data at the top of the area chart in figure 8. Virtually all of U.S. copper scrap export growth was attributable to Chinese imports thereof, which increased from 0.061 Mt of contained copper in 1995 to 0.569 Mt of contained copper in 2014, a 12.5 percent-per-year growth rate, compounded annually. From 1998 onward, China's demand for copper was much greater than could be fulfilled from primary smelting, so China was forced to go heavily into the world scrap market, thereby driving up copper scrap prices (Yue and Lu, 2006). China's consumption of copper, including that sourced from scrap, totaled 49 percent

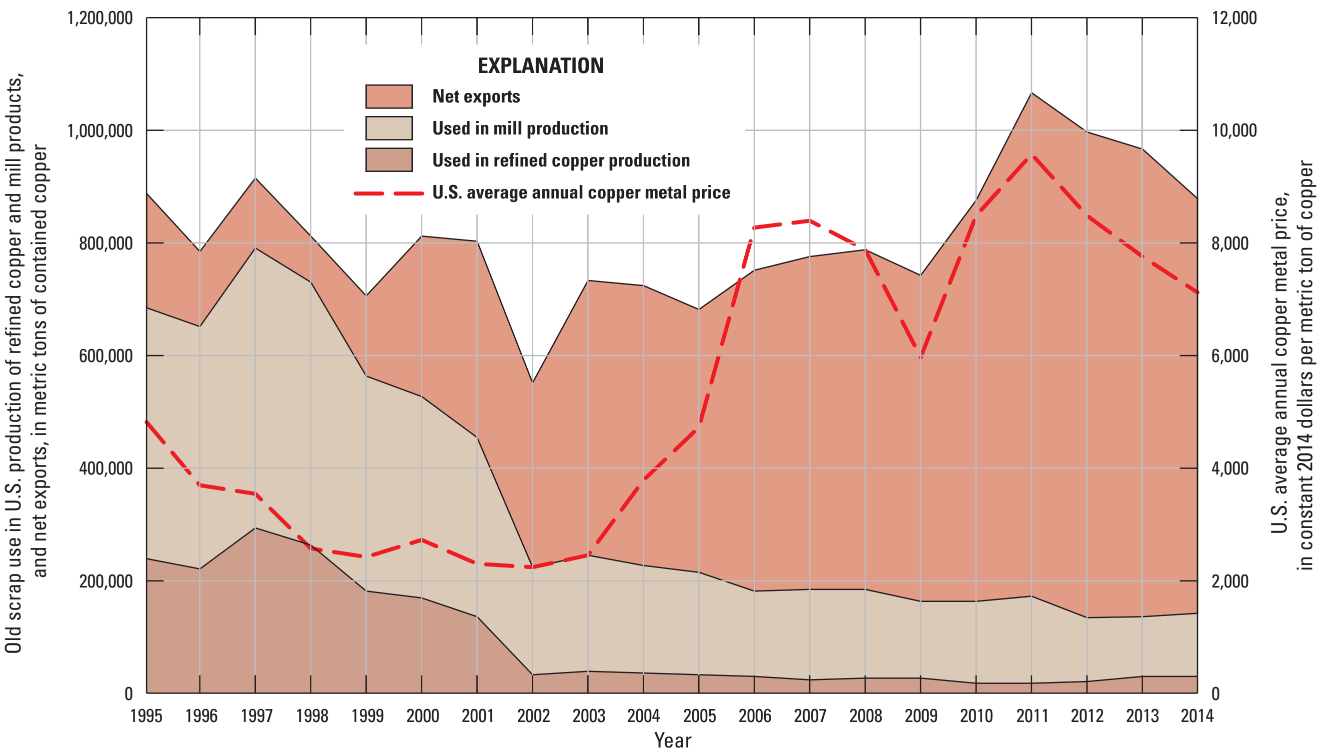

Figure 7. Area and line chart showing the use of old copper scrap in U.S. production, U.S. net exports of copper scrap, and U.S. average annual copper metal price, 1995 through 2014. U.S. average annual copper metal price is based on producer prices that have been discounted to constant 2014 dollars using the "Historical Consumer Price Index for All Urban Consumers" from the U.S. Department of Labor, Bureau of Labor Statistics (Crawford and others, 2016, p. 72). Production data from U.S. Geological Survey (1995–2013); Brininstool (2015a,b); Mark Brininstool, U.S. Geological Survey, unpub. data, 2016.

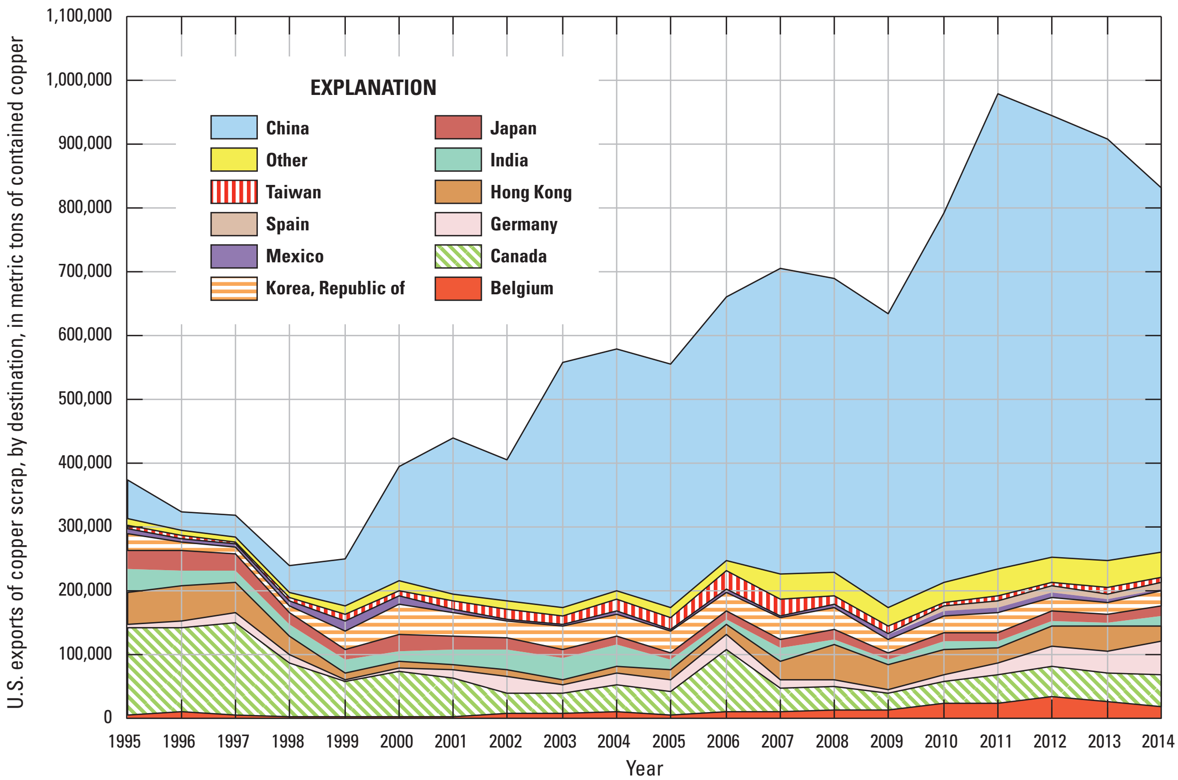

Figure 8. Area and line chart showing U.S. exports of copper scrap, by country, 1995 through 2014. Sources: U.S. Geological Survey (1995–2013); Brininstool (2015a,b); Mark Brininstool, U.S. Geological Survey, unpub. data, 2016.

of global production in 2014 (World Bureau of Metal Statistics, 2015). The trade-value of U.S. copper scrap exports in 2014 was $3.48 billion, and the trade-value of the Chinese fraction was $2.10 billion, or 60 percent.

In figure 9, U.S. net exports of copper scrap are shown with and without China included, and copper price is added.

Based on the endpoints of the linear trendline for U.S. net exports (China excluded), U.S. net exports to the rest of the world (the greater part of which are other Asian countries) increased 2.9 percent per year, compounded annually, over the study period. After 1998, Chinese imports of U.S. copper scrap (and therefore U.S. net exports [China included]) increased rapidly, and, as shown in figure 7, compensated for reductions in U.S. usage of old scrap for domestic production of refined copper and mill products. Essentially, a large part of the process of adding value to copper scrap through manufacturing was transferred from the United States to China. Regardless of the location of scrap value-enhancement, Chinese demand for copper drove copper metal prices from a year-2002 low of $2,230 (constant 2014 dollars per metric ton of copper) to a year-2011 high of $9,570 (constant 2014 dollars per metric ton of copper), a 4.3-fold increase. From 2011 through 2014, copper prices decreased to $7,120 (constant 2014 dollars per metric ton of copper).

Prices

Throughout this report, the price of copper metal (U.S. producer) has appeared in the graphics, even when the subject was scrap. Figure 10 shows the relationship of copper scrap prices (brass mill, refiners', and New York dealers' buying) to the copper metal price.

Figure 10 demonstrates that the prices for copper scrap are closely linked to the price of copper metal, such that use of the copper metal price throughout this report was warranted. Copper market supply and demand factors determine the price of copper and the price of copper scrap. The correlation is strongest for high-quality (clean, high copper content) scrap, but holds also for lower quality scrap.

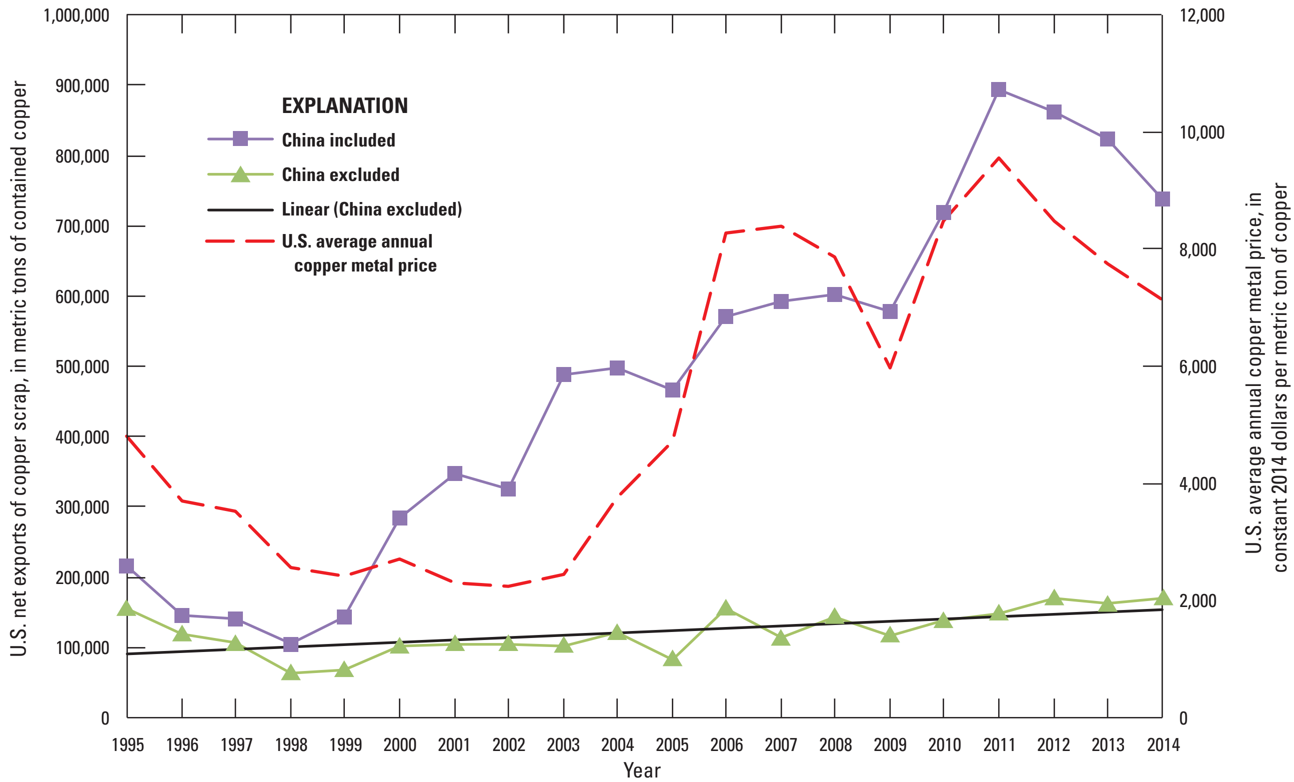

Figure 9. Line chart showing U.S. net exports of copper scrap, with and without China included, and U.S. average annual copper metal price, 1995 through 2014. U.S. copper producer prices have been discounted to constant 2014 dollars using the "Historical Consumer Price Index for All Urban Consumers" from the U.S. Department of Labor, Bureau of Labor Statistics (Crawford and others, 2016, p. 72). Production data from U.S. Geological Survey (1995–2013); Brininstool (2015a,b); Mark Brininstool, U.S. Geological Survey, unpub. data, 2016.

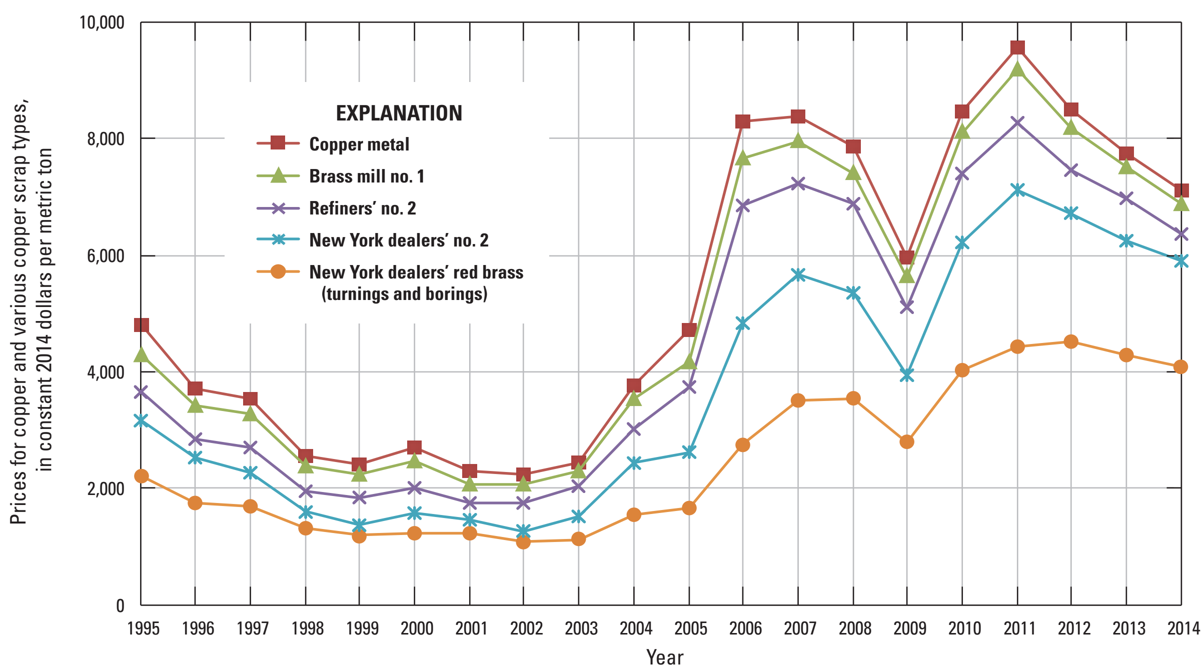

Figure 10. Line chart showing constant-dollar prices for copper metal and various types of copper scrap, 1995 through 2014. U.S. copper producer prices, as well as scrap prices as reported by American Metal Market, have all been discounted to constant 2014 dollars using the "Historical Consumer Price Index for All Urban Consumers" from the U.S. Department of Labor, Bureau of Labor Statistics (Crawford and others, 2016, p. 72). Production data from U.S. Geological Survey (1995–2013); Brininstool (2015a,b); Mark Brininstool, U.S. Geological Survey, unpub. data, 2016.

Summary

The worldwide demand for copper has increased, and much of that demand (49 percent in 2014) originated from China as its economy became increasingly industrialized to service both Chinese domestic consumption and Chinese exports of assembled products. China's demand for the world's copper resources has driven up copper prices. The United States, with its mature industrial economy and its shrinking refined copper industry, has been supplying increasingly more scrap to the world, mainly to China. Although the U.S. continues to fill part of its domestic demand for finished copper products by means of domestic production, it is acquiring copper-containing products to a greater degree from foreign sources, including China. Chinese demand for U.S. scrap decreased from its high in 2011 of 0.745 Mt of contained copper to 0.569 Mt in 2014, a 24 percent decrease. For the same period, the copper metal price decreased from $9,570 to $7,120 (constant 2014 dollars per metric ton of copper), a 26 percent decrease. If Chinese demand for copper falters further, there could be an additional oversupply of copper scrap, and prices could continue to fall.

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