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Minerals Price Increases and Volatility: Causes and Consequences

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Minerals Price Increases and Volatility: Causes and Consequences

Summary

A rise in the prices of minerals has had a major impact on U.S. manufacturers and consumers. Mineral prices have risen while the economy as a whole has entered a period of slowing growth. This has created serious difficulties for consuming industries and concern in Congress. This report reviews the increases in price across a wide range of metals commodities. Prices have at least nearly doubled between 2001 and 2008. In the case of steel, the most widely used industrial metal, the rise in price appears largely driven by the high prices of iron ore and steel scrap. Weak demand and increasing supply may reduce metals prices, but it is also widely believed that prices will not fall to the levels seen earlier in this decade. The long-term trend of declining real prices for metals inputs, which boosted the competitiveness of the U.S. industrial economy throughout the 20th century, may be over.

Fundamental changes in commodity markets may explain why a rise in metals prices is not simply a cyclical or temporary phenomenon. Consolidation of ownership of minerals companies has given them increased pricing power. Market speculation may have driven up the prices of mineral commodities. The 2000 Commodity Futures Modernization Act (P.L. 106-554) exempted both energy commodities and metals from regulation by the Commodity Futures Trading Commission (CFTC). The 2008 Farm Bill (P.L. 110-246) partially closed this exemption, and other bills have been introduced to extend CFTC regulation.

Another often-heard explanation for higher minerals prices is the ongoing and rapid industrial development of lower-income countries. This report discusses China's efforts to improve and increase its access to foreign mineral resources, which may have the effect of raising prices for U.S. domestic industrial users.

The report examines in detail the relationship between prices, production, and availability of selected metal minerals essential to the U.S. economy. It focuses on:

- Iron ore
- Aluminum (bauxite/alumina)
- Copper
- Manganese
- Molybdenum (moly)
- Zinc
- Platinum Group Metals (PGMs)
- Uranium

Domestic metals production generally declined since the 1990s, but has increased again in recent years. However, the upturn in supply has not been adequate to meet domestic or global demand. Congress has extensively debated the 1872 General Mining Law (30 U.S.C. 21-54), but, with the exception of uranium, the issue of mining on public lands has little relationship to the question of domestic supply of industrial metal minerals.

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Introduction[1]

Congress has been concerned with higher mineral prices and the effects on the U.S. industrial economy. Of course, the rise in price of petroleum and other mineral fuels has been a subject of great public concern and front page news.[2] But many manufacturers, and others in industries such as construction, have been at least equally concerned about recent surges in the price rises, especially in 2007-08, in steel and other metals. In the short run, Congress will consider the effect of higher material costs in public contracts, particularly in infrastructure projects financed by federal resources. More indirectly, the federal budget and domestic economic growth are being affected by layoffs and employment contraction as industries are hit by the double effects of slower economic growth and higher metal materials input costs.

There is also some evidence that the long-term decline in relative metals prices, as it evolved through most of the twentieth century, has been succeeded by an era in which metals prices are increasing relative to other economic inputs. As the United States has moved into a position in which it imports significant amounts (in some cases, virtually all) of its industrial metal ores, this could have a dampening effect on U.S. economic growth and industrial employment. Such a fundamental economic shift could have even more important consequences for policy makers than the shorter-term budgetary and employment impacts. Although metals mineral prices may have peaked in mid-2008 and may decline going forward, most analysts believe that they will not return to the much lower levels seen earlier in the decade.

The policy actions to reverse or ameliorate this situation may be relatively limited. Some Members have cited the possible impact of increased minerals commodity speculation, which they believe has artificially increased the price of oil and other industrial mineral commodities. They have supported legislation aimed at limiting the role of financial speculators. Members have also debated the question of mining on public lands, and whether U.S. mining laws should be reformed.

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[1] This section was written by Stephen Cooney, Resources, Science, and Industry Division, who also coordinated the report.

[2] This subject is discussed in CRS Report RL34625, *Gasoline and Oil Prices*, by Robert Pirog.

Organization of Report

The rise in metal minerals prices. The first substantive section of the report details the general increase in metals prices in the current decade. Since 2001, aluminum prices have nearly doubled, and a broad range of other metals commodities prices, included ferrous and non-ferrous scrap, have tripled or increased at a higher rate, even as U.S. economic growth has slowed. A separate sub-section reviews the across-the-board rise in prices of steel, the most widely used industrial metal.

Causes of minerals price increases. Some analysts have suggested that the structure of the market for minerals is fundamentally changing, and this has resulted in higher prices for U.S. industrial consumers of such materials. Such changes may be due both to the increased pressures of global supply and demand, as well as to active market manipulation. Causal factors that have been widely discussed, and which will be reviewed in detail, are:

- Consolidation and the development of oligopolies in metals and ore production;
- Increased commodities market speculation;
- Growth of demand for metals and metal ores among rapidly developing countries, especially China.

Metals mineral resources. While there are general trends that affect metals, supply, demand, and price developments are specific for each metal commodity. Any study of supply and demand of industrial metals must necessarily be selective. The report will review specific mineral resources, their sources and availability, and policy issues that may affect their availability in the U.S. economy.

Concern over the impact on the U.S. economy of nonfuel minerals availability led the National Research Council to prepare a study, *Minerals, Critical Minerals and the U.S. Economy* that will be referenced throughout the current CRS report.[3] The NRC study chose to focus primarily on those minerals that might be considered "critical" to the United States as defined by both the risk to supply of the mineral and the impact of any supply restriction. "The criticality matrix ... emphasizes that *importance in use* and *availability* (supply risk) are the key considerations in evaluating a mineral's criticality."[4] The NRC examined in detail three metal minerals as potentially critical under this definition: copper, rare earths (as a group), and platinum group metals (PGMs). It concluded that rare earths and PGMs could be defined as critical, but that copper was not — despite its importance of use, it was considered widely available. The NRC further examined some other metals and concluded that niobium, indium, and manganese might be defined as "critical," and

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[3] National Research Council. *Minerals, Critical Minerals and the U.S. Economy* (Washington, DC: National Academies Press, 2008). Hereafter NRC, *Critical Minerals*.

[4] Quote from NRC, *Critical Minerals*, p. 109. The criticality matrix is introduced and defined on pp. 5-6, 30-34.

gallium might be added to this list.[5] As with this CRS report, the NRC did not evaluate the "strategic" importance of minerals for national security.[6]

This CRS report takes a broader view of the significance of metal minerals for the economy. Consequently, the range of minerals upon which this report focuses are those that may be used more broadly in the economy than those on which the NRC focused, although there is some overlap. The specific metals studied in this report are:

- Iron ore
- Aluminum (bauxite/alumina)
- Copper
- Manganese
- Molybdenum (moly)
- Zinc
- Platinum group metals (PGMs)
- Uranium

This group covers a wide range of general and specialty uses. The first three products, in their refined state, are probably the most widely used industrial metals in the U.S. and global economies. Manganese and molybdenum are metals that are critical in the use and production of steel, while zinc is used to galvanize steel, especially for construction products. While these metals are all base metal commodities, platinum is a precious metal, mined and traded in small quantities. Together with the other PGMs, it plays an important role in the automotive industry. Uranium is chemically defined as a metal, though its importance is primarily as nuclear fuel. For some of these metals, U.S. industry is mostly reliant on domestic resources. For others, the United States is almost completely reliant on imports.

Issues for Congress. The report concludes with a review of the issues and legislation that Congress passed or considered, and its effects on mineral markets. It examines recent legislation to deal with commodities speculation, and concludes that it has so far only had limited effects on commodity markets and prices. The report also examines legislative proposals to reform the rules governing mining on federal lands, but notes that these issues primarily affect only gold, which is not considered as an industrial commodity, and uranium.

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[5] NRC, *Critical Minerals*, ch. 4.

[6] NRC, *Critical Minerals*, pp. 29-30.

Overview of Minerals Price Trends[7]

The Rise in Industrial Metals Prices

The U.S. industrial economy is affected by mineral prices, which have continued to rise — in some cases, accelerated — while economic growth has slowed. Rising materials input costs have become a major problem for many U.S. businesses, as noted in *Business Week*:

> More small business owners say higher costs are hammering profits, according to a June [2008] survey by the National Federation of Independent Business. For the first time since 1981, NFIB members say inflation is their top concern. Even excluding energy and food, wholesale prices for crude materials in June were up 33% from a year ago, while semi-finished intermediate goods, used to make final products, rose 8%. Both rates are triple those at this time [in 2007].[8]

A 2008 report for Lehman Brothers, a New York-based investment bank, calculated that the cost of mineral commodities in the average new motor vehicle as of February 2008 was $2,241, up by $421 (19%) over the cost one year earlier. This was contributing to higher vehicle prices, even though market demand in early 2008 was substantially down across the board — and especially for the larger and heavier vehicles that used more metal. According to this report, the average new vehicle contains 2,200 pounds of steel, 300 pounds of aluminum, and 60 pounds of copper. Even metals used in much smaller quantities contribute significantly to overall costs. The report noted, for example, that only small amounts of platinum and palladium, primarily used in catalytic converters, contributed 6% to the average commodity cost figure, because the price per pound is much higher than base metals. Despite efforts to reduce vehicle weight to improve fuel economy, the average new vehicle (car or light truck) sold in the United States today weighs more than 4,000 pounds, compared to 3,200 pounds in 1980. This change largely reflects the net effect of the consumer market shift to SUVs and trucks in the 1990s.[9] Another source calculated that the higher cost of steel alone in 2008 would add $250 million to General Motors' North American manufacturing costs, and $200 million to those of Ford Motor Company.[10]

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[7] This section was written by Stephen Cooney, Resources, Science, and Industry Division.

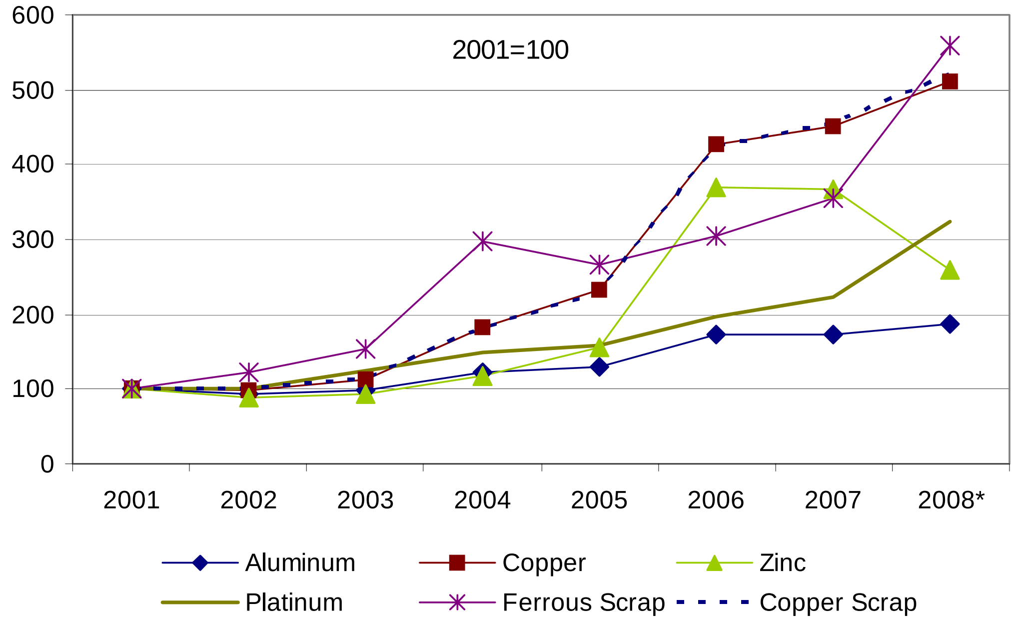
[8] "Earnings Are Heading into Even Rougher Seas," *Business Week* (July 28, 2008), p. 11.

[9] *American Metal Market* (*AMM*), "High Metal Prices Blamed for Auto Stagflation Threat" (March 12, 2008), p. 8. NRC, *Critical Minerals* notes as many as 39 different minerals may be used in modern automobiles. It cites weight statistics from the Minerals Information Institute similar to those above. NRC also analyzes the use of minerals in the aerospace, electronics and energy production industries, pp. 50-63.

[10] Analysis by Rod Lache of Deutsche Bank AG, reported in *Detroit News* (*detnews.com*), "Auto Briefs" (April 11, 2008). Auto parts supplier Dana Corp. predicted in mid-2008 that steel price increases would cost it $242 million in 2008, less than half of which could be recovered from price increases to customers; *AMM*, "High Steel Tags Widen Dana's Losses in 2nd Qtr." (August 8, 2008), p. 6.

While much less copper than steel is used in automotive manufacturing, the reverse is true in homebuilding. "Construction accounts for more than 40% of copper use, with about two-thirds of that attributed to residential building ... An average single-family house uses about 439 pounds of copper."[11] Thus, as the homebuilding industry struggles with the decline in U.S. home sales, it also faces higher basic material costs, led by copper and other metals.

Figure 1. Metals Prices



* Annual average as of June, 2008.

Source: *American Metal Market* (*AMM.com*) historical metals prices series.

Note: Definition of commodities —
Aluminum: COMEX spot price.
Copper: London Metal Exchg. Spot asking price.
Zinc: London Metal Exchg. Spot asking price.
Platinum: Engelhard producer price.
Ferrous scrap: Consumers' no. 1 heavy melting scrap price, Chicago.
Nonferrous (copper) scrap: Refiners' no. 1 quality.

Figure 1 illustrates how a rise in some selected metals prices used broadly across industry has occurred since the beginning of the decade. Except for zinc, among these metals inputs, the price rise continued or even accelerated in 2008, despite wide perceptions of an economic slowdown. The figure uses the 2001 average price of each industrial input as the base line. It shows the relative price increase of three base metals (aluminum, copper, zinc), one precious metal with significant industrial usage (platinum), and ferrous and non-ferrous scrap (in the

[11] *AMM* monthly ed., "Staring into the Abyss" (March 2008), p. 38.

latter case, copper).[12] Except for aluminum prices, all have at least tripled during the period, with both ferrous and non-ferrous scrap, and raw copper increasing about five times in price by early 2008. Moreover, in early 2008, all these commodities, except zinc (which, though declining somewhat in price since 2006, nevertheless remained historically high), exhibited continued price increases despite a slowdown in U.S. economic growth.[13]

Iron Ore and Steel Prices

The data in **Figure 1** do not include iron ore, which, after mineral fuels, is probably the mineral product most widely used by industry, primarily in the form of steel mill products. Iron ore prices internationally and domestically are set by contract. Moreover, the impact of increased prices of both iron ore and ferrous scrap input prices on the economy in this decade has been reflected primarily in rising prices of steel mill products, which will be reviewed separately below.[14]

Iron ore trades only in limited amounts in the open market. Internationally, the key price has been set in annual contract negotiations between the three largest international producers on the one side (the big Brazilian iron ore producer, Vale, and two large Australian producers, BHP Billiton and Rio Tinto) and the large Japanese and Korean steel producers on the other. Since 2004 the Chinese steel companies, negotiating as a group, have become the major importers, but they have not been able to lower the price set by the traditional negotiators. In 2005, after a booming global recovery in steel demand and explosive growth in China, Vale succeeded in negotiating a 71.5% annual increase in its contracted ore price. This was followed by successive annual increases of 19% and 9.5%; then in early 2008 Vale raised its price between 65% and 71%, depending on ore grade, to an average price of about $200 per metric ton (MT).[15] Citing the advantages of shorter shipping routes, Rio Tinto raised its price to Chinese iron ore consumers even more, by 96.5%, in 2008.[16]

The domestic U.S. steel industry is only indirectly affected by international iron ore price developments. The majority of steel in the United States, by tonnage, is produced in electric arc furnaces, in so-called “minimills,” which use scrap as their

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[12] Scrap is listed in NRC, *Critical Minerals* as a mineral resource. It distinguishes between “old scrap,” which is considered as a “secondary” mineral resource, and “new scrap,” waste material from manufacturing processes, which “is essentially primary material that requires an additional processing step to find its way into products;” pp. 91n and 101.

[13] On falling zinc prices in mid-2008, *AMM*, “‘Deathwatch’ Facing a Number of North American Zinc Mines” (July 21, 2008), p. 12.

[14] Note, in the following subsection, and throughout this report, that, internationally, large mineral volume units are generally measured in metric tons (about 2,200 pounds). This unit is abbreviated here as “MT.” Domestic production is often measured in “tons” (2,000 pounds), a term that is spelled out in the report.

[15] *AMM* print ed., “Soaring Ore Prices May Be the Bullet Beijing Needs” (April 2008), p. 71.

[16] *Financial Times*, “Chinese Agree 96% Jump in Ore Prices” (June 23, 2008).

primary charge.[17] Historically, this has enabled them to produce steel more quickly and cheaply than integrated mills using blast furnaces, and many types of product, such as reinforcing bars, steel beams, and most other construction steel products, are now only made domestically in minimills. But, as shown in **Figure 1**, ferrous scrap prices increased more than fivefold between 2001 and mid-2008. The United States is the world's leading exporter of ferrous scrap, and international buyers have increasingly competed for U.S. domestic scrap. While the supply base has remained relatively constant, U.S. exports have risen from about six million tons annually in 2000 to 12 million tons in 2004-06, 16 million tons in 2007, and an even higher rate in early 2008.[18] To protect their own domestic steel industries, some foreign countries have enacted restrictions on scrap exports, a policy that has been considered in the United States, but not adopted.[19]

Integrated mills must use iron ore to produce pig iron in blast furnaces as their principal ingredient for making steel. U.S. Steel, the largest single steelmaker in North America, supplies 100% of its iron ore from its own mines. ArcelorMittal, the internationally owned firm which is the other dominant North American integrated steel producer, owns substantial iron ore sources around the world, but only sufficient for 45% of its global needs. It is seeking to expand its holdings, both in North America and elsewhere. The major independent source of domestic iron ore is Cleveland-Cliffs, which sells most of its ore under long-term contracts, but which tends to follow the global iron ore price. Cleveland-Cliffs' price is reported to have increased from a 2007 average of $66 per ton to about $85 in 2008.[20] The company reportedly has further issued "guidance" that it expects its average price in 2009 to be at least $107 per ton.[21]

With North American ore prices much lower than the internationally traded Brazilian and Australian ores, the former price advantage of both the domestic minimills and imports over the integrated mills has been reversed. World Steel Dynamics, an industry consulting and data services firm, reported in 2008 a total

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[17] CRS Report RL32333, *Steel: Price and Policy Issues*, p. 4 and table 1.

[18] Ferrous scrap trade data quoted from *AMM*, "Scrap Users Unite to 'Level the Playing Field'" (June 16, 2008), pp. 1-2; and, "Ferrous Exports Rocket, Sparking Fears on Trade" (July 16, 2008), pp. 1 and 7. Note some decline in U.S. scrap prices and exports in mid-2008 and turmoil in the market, but price falls have been marginal compared to earlier price increases; *ibid.* "Ferrous Scrap Pricing Plunges Up to $70/Ton" (August 8, 2008).

[19] The American Scrap Coalition has been formed to try to eliminate such barriers to global trade in scrap; see *ibid.* A summary of recent measures by foreign governments to restrict or discourage exports of scrap is listed by Michele Applebaum in *Steel Market Intelligence*, "Resource-Hugging — Reverse Protectionism Will Drive Further Commodity Price Hikes" (June 12, 2008), p. 2. Moreover, Russia has reportedly drafted a decree to reverse negotiated decreases in scrap export taxes; *AMM*, "Export Tariffs by Developing Countries to Hurt Supply: BIR" (August 7, 2008), p. 10. On responses by the U.S. Trade Representative and the European Union to reduce such restrictions, and on U.S. rejection of "short supply" export controls on ferrous and non-ferrous scrap, see CRS Report RL32333, pp. 23-25.

[20] *AMM*, "Vale's Big Score Seen Benefitting North American Mines, Mills" (March 21, 2008); "Canadian Iron Ore Producers in Buy-Out Deal" (April 22, 2008), p. 4.

[21] *AMM*, "Cliffs Raising 2008 Guidance on Ore" (July 10, 2008), p. 8.

price advantage for North American integrated mills in producing cold-rolled coil steel of about $130 per ton under the cost of minimills.[22] Nucor, the largest U.S. minimill producer, is reported to be planning to build a large new blast furnace to offset this cost disadvantage.[23] Meanwhile the weak exchange rate of the dollar, continued trade remedy tariffs on products from some countries, and high ocean freight rates have combined to discourage steel imports.[24]

Because it is difficult to develop meaningful and comparable price series for iron ore, and because U.S. steel mills may use iron ore or scrap as their principal charge, this report shows instead the price changes for a wide range of steel mill products, which are the most widely used intermediate goods produced from iron ore (all ferrous scrap was originally processed from iron ore). Some sample product prices since 2001 are illustrated in **Table 1**. They show roughly the same magnitude of price increases as displayed for mineral prices.

As with mineral commodities, by 2007 many steel mill product prices were double or triple the levels seen earlier in the decade. This price increase put serious pressure on consuming industries, as many smaller manufacturers and other steel consumers testified before Congress in 2004.[25] As seen in **Table 1**, the prices either declined or rose more slowly between 2004 and 2007. But in early 2008, there was a further run-up in most steel product prices, even though demand for final goods using steel products was not nearly so robust. The clearest example is in sheet steel, which, in the first half of 2008 averaged $300 per ton higher than in 2007, despite declines in homebuilding and automotive production. Only stainless steel products showed a small price decline in early 2008.

This price escalation in 2008 is shown in more detail in **Figure 2**. This illustrates the monthly movement of prices for some representative steel products in **Table 1** from 2007 to early 2008, normalized at the January 2007 level. The figure illustrates prices rising for four products (carbon sheet, coiled plate, rebar, and low-carbon industrial rod) by 50% to more than 100% higher than the level of January 2007. Momentum built late in 2007 and early 2008, just as the overall U.S. economy was slowing. Even special bar quality steel, widely used in the automotive industry, followed the pattern with a 20% increase in price, despite declining motor vehicle production.

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[22] World Steel Dynamics, *Steel Cost Curve Monitor* (May 23, 2008), table on p. 2.

[23] *AMM*, "Nucor Eyes Building $3B Iron-Making Facility in La." (May 16, 2008); see also, "Southeast Asia Looking More to Blast Furnaces" in the same source.

[24] Another major cost increase for integrated steelmakers worldwide is the cost of coking coal. "Annual benchmark ... prices ... have jumped to around $250 to $300 per ton recently from less than $50 per ton just five years ago," according to U.S. Steel CEO John Surma. *Ibid.*, "Surma Says Steel Still Best Material for Auto Industry" (April 10, 2008), p. 6.

[25] See U.S. House. Committee on Small Business. *Spike in Metal Prices — What Does it Mean for Small Manufacturers?* Hearings, March 10 and 25, 2004 (serial nos. 108-57&59).

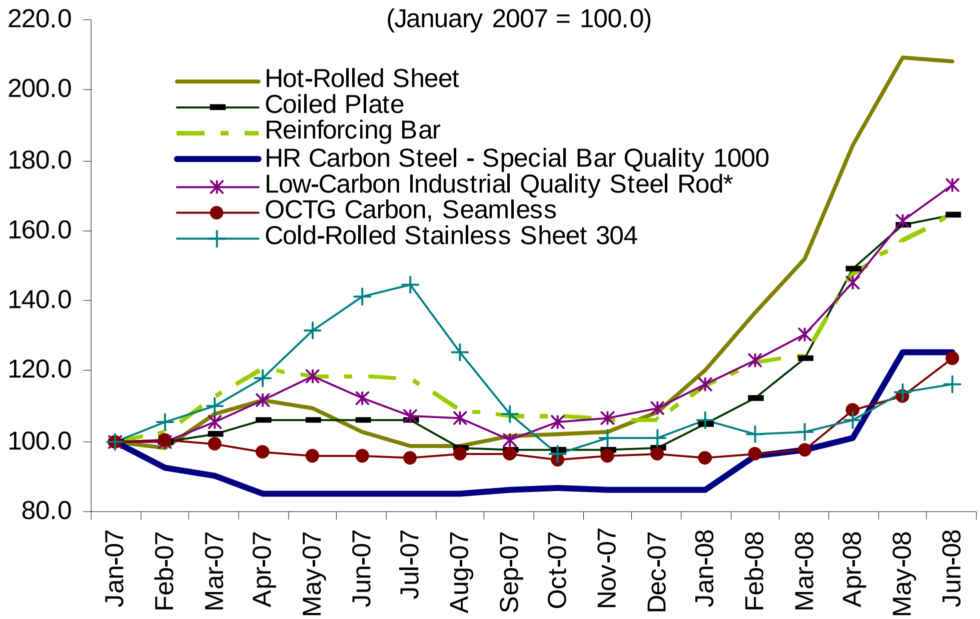
Table 1. U.S. Steel Prices

Products	Annual Average Price Per Short Ton ($)							
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Flat Products								thru mid-June
(Sheet)								
Hot-Rolled Sheet	234.20	329.20	296.00	616.80	556.60	595.60	537.80	876.40
Cold-Rolled Sheet	318.60	421.60	382.60	693.40	646.80	695.00	627.40	960.00
Hot-Dipped Galvanized Sheet	328.20	440.00	401.60	733.80	675.40	761.80	765.00	1077.20
(Plate)								
Cut-to-Length Plate	258.00	305.00	314.20	638.40	792.20	829.20	821.00	1101.80
Coiled Plate	240.00	313.80	320.40	674.00	819.80	829.20	821.00	1103.60
Long Products								
(Bar)								
Reinforcing Bar	310.00	306.20	317.80	446.60	485.60	525.60	598.20	751.40
HR Carbon Steel - Special Bar Quality 1000	340.00	353.20	371.60	546.40	719.20	838.00	721.80	865.20
Cold-Finished Carbon Steel 1018	455.20	465.20	503.00	773.40	899.20	880.40	905.20	977.00
Merchant Angles (2”x2”x1/4” std. size)	287.60	252.00	306.00	482.00	520.20	582.20	661.20	845.60
(Rod)								
Low-Carbon Industrial Quality[a]	310.00	317.40	323.00	567.60	583.00	591.80	652.80	854.40
High-Carbon[a]	330.00	330.00	333.00	598.80	605.00	618.00	679.00	884.40
Tubular Products (Oil Country Tubular Goods)								
OCTG Carbon, Welded	880.06	810.58	787.87	1130.53	1344.95	1367.82	1305.61	1454.94
OCTG Carbon, Seamless	1008.72	925.52	883.52	1227.58	1534.19	1567.20	1488.08	1628.85
OCTG N80, Welded	1071.43	999.24	997.78	1341.38	1613.83	1735.27	1677.98	1807.13
OCTG N80, Seamless	1163.12	1091.54	1072.11	1421.51	1764.14	1869.34	1812.60	1978.01
Stainless Steel								
Cold-Rolled Sheet 304	1376.40	1300.60	1295.20	1734.40	2514.60	3287.20	4827.20	4510.60

Source: Annual average price data from *American Metal Market* historical steel base price series. Except for OCTG, prices converted from cwt. to per ton basis by CRS. Selected categories based on those used by Global Insight consultancy in its *Steel Monthly Report* forecasts.

a. Product definition adjusted in 2007.

Figure 2. Steel Monthly Average Prices



*Source uses discontinued series for Jan.-Mar. 2007.

Source: As for Table 1.

Many analysts believe that the prices of early 2008 for basic minerals and the intermediate products made from them will not continue to rise or to remain at that level for a prolonged period. In a widely quoted presentation, for example, Peter Marcus of World Steel Dynamics predicted that hot-rolled coil steel could fall from quoted prices of more than $1,000 per MT in mid-2008 to $650-$750 by the fourth quarter.[26] With respect to iron ore, John Anton of the economics consulting firm Global Insight has pointed out that global steel production increased 5.8% from mid-2007 to mid-2008, compared to output increases by the three big international firms of 9% to 23% — and with even larger output increases projected for 2009.[27] With respect to ferrous scrap, steel industry analyst Michelle Applebaum has cited fall in prices in September 2008, which "are down the most for a single month ever."[28]

While there is some question whether the elevated prices of early 2008 for many minerals and mineral products (notably steel) can be sustained through 2008, there seems to be little prospect of basic prices for such commodities and their products

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[26] His views are outlined in World Steel Dynamics, *Inside Track #87*, "World Export Price to Plummet 2H 2008" (June 12, 2008), esp. p. 3. A global commodity index created by Standard & Poor's and Goldman Sachs Group investment bankers declined by 19% in mid-2008; *Business Week*, "Commodities Are Down ... Hooray?" (August 18, 2008), p. 26.

[27] Global Insight. "Could Iron Ore Prices Weaken in 2009?" *Steel Monthly Report* (August 2008), p. 1.

[28] In her *Steel Market Intelligence* (September 10, 2008), p. 1.

to return to the low levels of 2001-2002.[29] While U.S. economic growth and that of other industrial countries may be slowing down, economic growth is expected to remain strong in most emerging market countries, even if somewhat lower than previously forecast.[30] Many mineral analysts conclude that in today's global economy, demand and prices for basic mineral inputs will remain historically high.[31]

A Reversal of the Twentieth Century Decline in Metals Prices?

If prices of metals mineral ores and products remain near recent levels, it would be a fundamental change from an historic pattern that underpinned U.S. industrial development in the twentieth century. The National Research Council's 2008 report on minerals cites a U.S. Geological Survey (USGS) analysis as concluding:

> The overall price of mineral commodities declined in the twentieth century despite increases in consumption: supply and competition were adequate and technology improvements decreased the cost of production and supply.[32]

The USGS analysis distinguished between "industrial mineral commodities" (such as cement, clay, lime, and crushed stone) and five "metal commodities" mined in the United States: copper, gold, iron ore, lead and zinc. The metals price index was marginally down on a real basis, with copper, lead, and zinc declining in price, while iron ore and gold were up slightly over the full century. Copper notably declined from more than $2.00 per pound in 1900 (in 1997 constant dollars), to just above $1.00 by the end of the century. The downward trend of metals prices would have been clearer had it not been for a major price spike between the early 1970s and the early 1980s. Aluminum, considered separately because little bauxite ore is mined in the United States, fell even faster in price. In constant dollars per pound, it had

[29] Despite the possibility of a sharp steel price fall ahead, World Steel Dynamics predicts that the "global steel demand outlook ... seems bright longer-term" (through 2017). Anton has forecast typical spot steel price declines of only 20% or less by the end of 2009; Global Insight, *Steel Monthly Report* (May 2008), p. 7.

[30] International Monetary Fund (IMF), *World Economic Outlook* (April 2008), table 1.1; Michael Mussa, Peterson Institute for International Economics (formerly Director of Research, IMF), "Global Economic Prospects: Suffering a Mild Case of Stagflation" (September 26, 2008).

[31] Mussa, cited above, stated that, " ... [T]he broad upsurge in commodity prices has been largely if not completely reversed," but in oral remarks stated that there would be "no 'crash' in global commodity prices." John Anton has been "bearish" about steel prices maintaining the high levels of early 2008 going forward — but foresaw only a "fall back to 2007 prices." Cited in *AMM*, "No Ills from AAM Strike So Far, Steelmakers Say" (April 7, 2008), p. 4. Subsequently, he forecast, "Steel prices generally increased about US$500 [per ton]; we roughly estimate that $300-350 will go away, but $150-200 will remain as a new higher floor."Global Insight, *Steel Monthly Report* (July 2008), p. 2. Also, see *World Steel Dynamics*, "Truth & Consequences #47" (April 3, 2008), p. 2. Similarly, while U.S. aluminum prices and production fell in the second half of 2008, production elsewhere continued to rise; see *AMM* articles of September 23, 2008, pp. 1 and 8.

[32] NRC, *Critical Minerals*, p. 89.

declined from an average value of more than $5 per pound before 1920 to substantially less than $1 by 2000.[33]

Price increases since 2001 mark a clear change from long-term downward trends or stable costs of metal inputs for industry. The metals commodities in **Figure 1** displayed price increases in this decade ranging between nearly 100% for aluminum to more than 500% for copper and copper scrap. Steel prices in **Table 1** mostly doubled, tripled or even quadrupled over the 2001 level. By comparison, the Consumer Price Index (used in the USGS study to deflate twentieth century metals prices) has only increased 24% since 2000.[34] If metals analysts are correct that most of the increase in metals commodity prices is not a temporary bubble, but represents a long-term shift in the relative value of such industrial inputs, the consequences may be significant for future U.S. economic growth and competitiveness.

Commodity Markets and Minerals Price Increases[35]

In many ways, the commodity markets, including those of the metals covered in this report, are similar to markets for consumer goods, but in several specific ways, they differ. The major similarity between commodity and consumer goods markets is that, in both cases, their prices are determined through the interaction of demand and supply. In the case of many commodity markets, there are actually two markets that contribute in the price determination process:

- The first is the real, physical, commodity market. It is composed of firms that use these commodities in production processes, and thus create the demand side of the market. The other part consists of the firms that supply this physical market.

- The second market is the financial market, which is composed of firms that desire price predictability, and hedge real commodity market transactions, and financial speculators, who are willing to accept the risk that real commodity users wish to reduce. Risk transfer of this type is a key factor in enhancing market efficiency, ensuring a relatively stable cost structure that can translate into less volatile consumer prices on the market.

In recent years, an additional class of speculators, financial investors, have begun to use commodity markets as portfolio investment instruments. Critics have asserted that this new class of speculators has contributed to increased commodity prices, as well as price volatility. Others counter that, unless special conditions exist that have created a financial "bubble", these new participants in the financial

[33] U.S. Dept. of the Interior. U.S. Geological Survey. "20th Century U.S. Mineral Prices Decline in Constant Dollars," by Daniel E. Sullivan, John L. Sznopek, and Lorie A. Wagner (Open File Report 00-389).

[34] U.S. Dept. of Labor. Bureau of Labor Statistics. "Inflation Calculator," April 22, 2008.

[35] Prepared by Robert Pirog, Resources, Science, and Industry Division.

markets represent transactions similar to those already taking in place in the market, and are unlikely to affect prices in any systematic manner.

Demand for Commodities

The demand for metals commodities differs from consumer goods demand because it is a *derived demand.* A derived demand is characterized as one for which ultimate consumers have no direct need for the commodity itself as a consumer good. The purpose of these goods is largely to serve as inputs in the production process of other goods that do serve ultimate consumer needs. As a result, the demand for metals commodities, in general, depends on the strength of the demand of the consumable goods for which they are inputs. This characteristic of derived demand has several important implications for the demand relationship and how prices are determined.

Economists theorize that the law of demand holds for essentially all commodities. This law states that when the price of a good rises, the quantity demanded falls. In the case of derived demand, the relationship is more complicated. The extent to which the quantity demand declines when the price of a metal rises depends largely on the degree to which its price increase can be passed on to the final consumer, as well as the proportion of the final good's price that is accounted for by the metal commodity. For example, if a final consumer good is viewed as an essential by consumers, and only a small fraction of its price is related to the cost of the metal contained in it, it is likely that the metal's quantity demanded (at least the part related to that particular consumer good) will be insensitive to changes in its price. In this case, the seller of metal commodity will be able to pass through the price increase of the metal, and the metal quantity demanded will be relatively insensitive to price increases.

Alternatively, the cost of a metal may be a significant proportion of the cost of the final consumer good. This final product may be subject to intense competition from other products, and the metal may be subject to a highly price sensitive demand. Then the producers of that metal might not be able to pass price increases on to final commodity users, and might themselves face a highly price-sensitive demand relationship. In addition, it may be possible to substitute other materials for the metal in question when its price increases. If substitutes are available, then once a critical price is reached, demand may move to the substitute commodities, resulting in reduced quantities demanded of the primary metal commodity. In the residential home market, copper was used for water pipe systems, but was replaced by plastic pipe as a result of cost pressures.

As a result of these price effects, it is possible that the quantity demanded of metals commodities might either remain relatively stable, grow, or decline, when their own prices increase.

For goods that are characterized by derived demand, the demand conditions for the final consumer goods to which they contribute are key factors. The major variables that determine the growth in demand for consumer's goods are price and income growth. General consumer price changes are measured by changes in the consumer price index (CPI).

Table 2. Increase in Consumer Prices (CPI)

(percent)

Year	Increase in CPI	Year	Increase in CPI
2007	4.08	2002	2.37
2006	3.06	2001	1.55
2005	2.88	2000	3.38
2004	3.25	1999	2.68
2003	1.87	1998	1.61

Source: U.S. Dept. of Labor. Bureau of Labor Statistics, available at [http://www.bls.gov].

Note: CPI growth is calculated from December to December.

Table 2 shows that although consumer prices have increased since 2004, their increase has remained less than the growth in the prices of minerals and steel products, as shown earlier in this report. Moderate growth in consumer prices suggests that either mineral materials costs were not passed on to consumers, or if they were, the cost of minerals were only a small fraction of the total cost of the consumer products. Other explanations are that falling labor costs could have offset rising material costs. This factor might be important for goods whose production has shifted to China, or other emerging market nations. Substitutes might also have been identified for some mineral commodities (e.g. plastic pipe for copper), which would result in reduced quantities demanded.

Income growth as measured by the growth in world gross domestic product (GDP) has been rising since 2003. World GDP growth rates, coupled with relatively low prices for goods coming from low-wage economies entering the global economy have likely increased the demand for metals for the production of all types of goods. With GDP growth accelerating over the period, growth in demand for mineral commodities could occur, even though prices were rising.

Growth rates in China have been a major driver of higher world GDP growth rates. As shown in **Table 3,** China's growth has been over double that of the world as a whole for each of the reported years, except 2005. During this period China's economy began a process of transition, from supplying goods to the rest of the world, to producing to satisfy rising domestic demand, fueled by growing income and wealth.

Table 3. World Gross Domestic Product Growth Rates
(percent)

Year	World Growth Rate	China Growth Rate
2003	2.7	8.0
2004	3.8	9.1
2005	4.9	9.1
2006	4.7	10.2
2007	5.3	10.7
2008	5.2	11.4

Source: Central Intelligence Agency. *The 2008 World Factbook*, May 2008.

Although the Central Intelligence Agency forecasts GDP growth of 11.4% for China in 2008, the weakening of the world economy might lead to lower growth.[36] The International Monetary Fund estimated Chinese GDP growth at 9.2% for 2008.[37] A lower rate of world and Chinese GDP growth would be likely to slow the growth in demand for minerals commodities and moderate prices.

A subsequent section of this report reviews specifically Chinese government policies and actions to secure access to mineral resources necessary to support China's domestic industries. This may have the collateral effect of raising prices for metal minerals resources well above price changes previously associated with given levels of economic activity in the United States and other advanced industrial economies.

Supply of Commodities

Economists theorize that, under ideal market conditions, firms will tend to supply more of a good to the market when its price rises. The logic suggests that firms can employ more resources used in the production process, even if those added resources are less productive, or more expensive, as the price, of the good being produced, rises. This analysis is partially applicable to the metals markets; however, significant differences exist between metals and manufactured goods in general.

Metals production depends on the existence of a resource deposit, and is capital intensive. These two factors limit the potential for short-term expansion of output. Although existing mines may expand production in the short run and utilize any accumulation of stockpiled ore, capacity limitations exist. In the longer term, new mineral deposits must be identified and specialized equipment may take time to

[36] Central Intelligence Agency, *The World FactBook 2008*, updated September 4, 2008.

[37] International Monetary Fund, *2008 World Economic Outlook*, April 2008.

procure, both of which limit the potential of the industries to respond quickly to high prices with more production. If the financial performance of the firms are weak, then the industry may experience difficulty in obtaining funding for additional equipment. Larger scale expansion of output may require the location and development of a new ore bodies, which may take substantial capital investment and a long development period.

Because of the need to find new reserves, as well as historically cyclical behavior of metals demand, little new entry into the industry might be expected in response to higher prices. With limited potential for output expansion from existing firms and little potential for the entry of new firms offering additional output, the supply conditions in the market may be characterized as inelastic, or relatively insensitive to price changes.

Market Power

Market imperfections may cause observed prices on commodity markets to differ from those that would be set under competitive market conditions. A key market imperfection can be the actual, or potential, use of market power. Market power exists when a market participant, usually a firm, or group of firms, can manipulate or influence the market to its benefit. In this sense, the market is controlled by a firm with market power.

Market power can be accumulated through the process of merger and acquisition. The decreasing number of competitors, coupled with the growing size of the remaining firms in the industry makes it more likely that potential market power could exist. Merger and acquisition activity in the metals industries accelerated in 2007 to an estimated 411disclosed deals, compared with 385 deals in 2006. However, the value of those deals increased from some $86.4 billion in 2006 to $144.7 billion in 2007. Of these 2007 deals, 115, worth in total about $77 billion, took place in North America. Rio Tinto's takeover of Alcan alone accounted for nearly half of the total value.[38]

The aluminum sector, as a result of two major transactions, became more concentrated. The top five global producers increased their share of production to 41% in 2007, up from 38% in 2006. The base metals sector experienced less activity, with 106 transactions in 2007, up from 88 in 2006. Major transactions were in the zinc industry, where the Australian firm, Zinifex, and the Belgian firm, Umicore, came together to form Nyrstar, the world's largest zinc smelter, with operations in seven countries. The steel sector experienced 249 deals in 2007, down by about a quarter from 2006.[39] However, as opposed to about a dozen companies that operated integrated steel mills in North America ten years ago, just three companies

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[38] Price Waterhouse Coopers, *Mergers and Acquisition Activity in the Global Metals Industry 2007*, p. 5.

[39] *Ibid.* pp. 7-12.

(ArcelorMittal, U.S. Steel, and Severstal) now dominate this part the industry. There has been a similar consolidation on the minimill side of the business.[40]

Market Prices

Markets with inelastic supply, as well as inelastic demand, are likely to have volatile prices. If demand increases, price might increase sharply, because little extra output enters the market to offset the additional demand. Under these conditions, price increases ration the good to high-value users (who can afford the higher price) and effectively force low-value users of the commodity out of the market, a process called demand destruction. Only those uses that can bear the higher costs of the commodity will continue to procure adequate supply. Similarly, if supply is reduced, prices are likely to increase sharply because of buyers' relative insensitivity to price variations, especially if cost increases can be passed on through the production process to final consumers.

During most of the past century, commodity prices have trended downward relative to manufactured goods at a rate of about 1.6% per year.[41] However, the downward trend has been interrupted by price spikes in the mid 1970s, the late 1980s, and again, since 2003. The declining prices of the 1990s may have created conditions that led to the recent price increases. Poor incentives to expand capacity, low investment due to declining profit expectations, and a long-term decline in real prices (net of inflation) likely left the minerals industries unable to expand to meet the needs of a world economy whose GDP growth rates accelerated as shown in **Table 3**.

If mineral prices are strongly correlated with the business cycle, and virtually every period of rising prices is tied to increasing world GDP growth, it is likely that a world economic slowdown in 2008 could lead to moderating prices. For the future, the major question is whether the industries have used the recent period of high prices to begin expanding to meet the requirements of the next growth surge.

Financial Markets

In addition to physical spot market and contractual relationships, many commodities, including metals, are traded on forward exchanges. These market activities are represented by futures contracts and options on futures contracts. Historically, these markets have served the valuable function of allowing commodity producers and consumers to guarantee future prices and costs, reducing risk. For this type of hedging activity to work, financial traders take financial positions opposite that of the commodity buyers and sellers. Through this type of transaction, price risk is transferred from the real commodity market to the speculator. Although economists have debated whether this type of activity increases or decreases price

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[40] On steel industry consolidation, see CRS Report RL32333, *Steel: Price and Policy Issues*, pp. 7-14.

[41] International Monetary Fund, *2006 World Economic Outlook*, September 2006, Chapter 5, pp. 2-3.

volatility in a market, few have claimed that excess price volatility, or a sustained upward movement in prices, occurs as a result of hedging transactions.

Recently, new kinds of investors have entered commodity markets, including metals markets, possibly contributing to the price increases of the past several years. These investors are interested in neither the real commodity market, nor the speculation on price movements of the traditional hedging transaction. These new investors, including pension funds, university endowments and insurance companies, are taking long (ownership) positions in the commodity futures markets purely as long-term portfolio investments.

Investors might be interested in this type of transaction because they are thought to contribute to risk reduction for the overall portfolio. The risk associated with price movements for individual securities is thought to be minimized through diversification. After an investment portfolio is fully diversified to essentially eliminate the risk associated with individual securities, market risk remains. Market risk is associated with price movements of the market as a whole. The reason portfolio investors find the commodities futures market attractive, is that many believe that price movements in commodities tend to counter price movements in equity markets. This counter price movement is a factor in reducing the market risk of an investment portfolio.

For example, if the price of a metal rises, implying the possibility of consumer price increases, and possibly a contribution to general inflation, equity markets might respond with falling share prices for specific firms, or industries, or even the equity market as a whole. However, rising prices for the metal in the futures market creates value for investors who are long, or in an ownership position, in futures contracts, offsetting potential losses in the equity market. In this way, market risk may be reduced by diversification into futures markets. This type of investment can be achieved through the purchase of commodity index funds. These funds have the further benefit to investors in that the index is composed of a substantial number of commodity contracts in many different markets, further contributing to the diversification of the overall portfolio.[42]

Because portfolio investors are interested in longer term positions, they may use a "buy and hold" investment strategy. As a result, a potentially permanent increase in demand occurs in the futures market, raising prices, and keeping them elevated as long positions are "rolled over" and new investors are attracted to the market to follow the success of earlier investors. Index speculators have increased their claim on a variety of metals over the period 2003 to 2008 as shown in **Table 4**.

[42] The Standard & Poor's-Goldman Sachs and the Dow Jones-AIG commodity indexes are commonly used in this type of investment.

Table 4. Index Speculator Commodity Holdings, 2003-2008

(metric tons)

Base Metal	Holdings Jan. 1, 2003	Holdings Mar. 12, 2008	Net Increment	Percent Change
Aluminum	344,246	3,576,652	3,232,406	939%
Lead	82,019	240,745	158,726	194%
Nickel	20,147	122,135	101,998	506%
Zinc	133,381	1,315,472	1,182,091	886%
Copper	220,096	1,364,634	1,144,538	520%

Source: U.S. Senate. Committee on Homeland Security and Governmental Affairs. *Financial Speculation in Commodity Markets (*Hearing on , May 20, 2008), testimony of Michael W. Masters.

Supporters of the viewpoint that speculation on futures markets is fueling price increases in commodities point to the data in **Table 4** as evidence that the demand for commodities has increased due to the activities of financial investors. The question remains whether the paper demand for metals commodities represented by the futures contracts held by the various financial funds is likely to result in real commodity demand anytime in the future. In general, the answer appears to be that it will not. Futures contracts are settled in cash or by delivery of the commodity as the contract matures. Experience suggests that cash is the preferred settlement method. If the settlement payment is not used to buy the metal on the spot market, but is simply recycled into futures contracts or other financial assets, the holdings represented in **Table 4** represent a different category of demand, less likely to result in upward market price pressure than real spot or contract demand.

The price increases in the commodity futures markets that likely have resulted from the increased holdings by index speculators and other financial participants have occurred during the same time period as the increase in real commodity prices.

Table 5. Commodity Futures Price Increases

(March 2003-March 2008)

Base Metal	Price Increase
Aluminum	120%
Lead	564%
Nickel	282%
Zinc	225%
Copper	413%

Source: As for **Table 4**.

Table 5 presents data on the extent of price increases on futures markets for key metals. It is possible that the futures markets and the real commodity markets have worked in tandem. It may be that the underlying demand and supply conditions in the real commodity market, largely related to high world GDP growth and a lack of expanded productive capacity due to a prolonged period of low, and declining prices, has resulted in a tight market with a bias for increasing prices. The later sections of this report that review specific mineral commodities show for many of them a period of output decline, especially in the domestic U.S. market, followed by a period of increased output starting around 2003. However, the increased output has not kept pace, either domestically or internationally, with GDP growth, resulting in a rapid rise in price. This has been coupled with a financial market that has consistently bought into the market since 2003 for investment reasons. The result has been "financial bets" on the futures markets that prices will increase. These "financial bets" have largely been validated by tight market conditions on the real commodity markets. If this interaction has resulted in a financial-real market price spiral, it might reverse itself when world GDP growth slows.

China's Growing Role as a Minerals Consumer[43]

China's strategic minerals policy stems from a vision of where its leaders want the country to go over the near future. It is partly born of exigency, partly of legacy, and partly of ideology. As is the case for any nation, China faces two vital national interests plus one existential interest for the country's leaders.[44] The vital interests are security and prosperity, while the particular interest is the survival of the Chinese Communist Party as the sole ruler of China. All of these interests rest upon continued economic growth and the transformation of the economy and country into a major industrial power. Economic growth finances the military, diplomacy, foreign aid and investment, and other means to obtain both internal and external security and territorial integrity. Economic growth is key to the country's prosperity and the lifting of people out of poverty. It also is key to providing legitimacy for sole rule by the Party, and for garnering popular support and moderating dissent.

This exigent need for rapid economic growth has combined with China's legacy of being subject to trade boycotts and the mind set of economic control — a legacy from socialism — to generate policies that ultimately reach deep into the hinterlands of the world and challenge long dominance both by Western transnational corporations and by international financial institutions (such as the World Bank) in certain countries. For China, a major disruption in the supply of copper, iron ore, petroleum, or other industrially important minerals could devastate its industries and quickly generate instability in society. For the regime in Beijing, instability is the major internal threat to its privileged rule, and policy makers consider stability as a

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[43] Prepared by Dick K. Nanto, Foreign Affairs, Defense, and Trade Division.

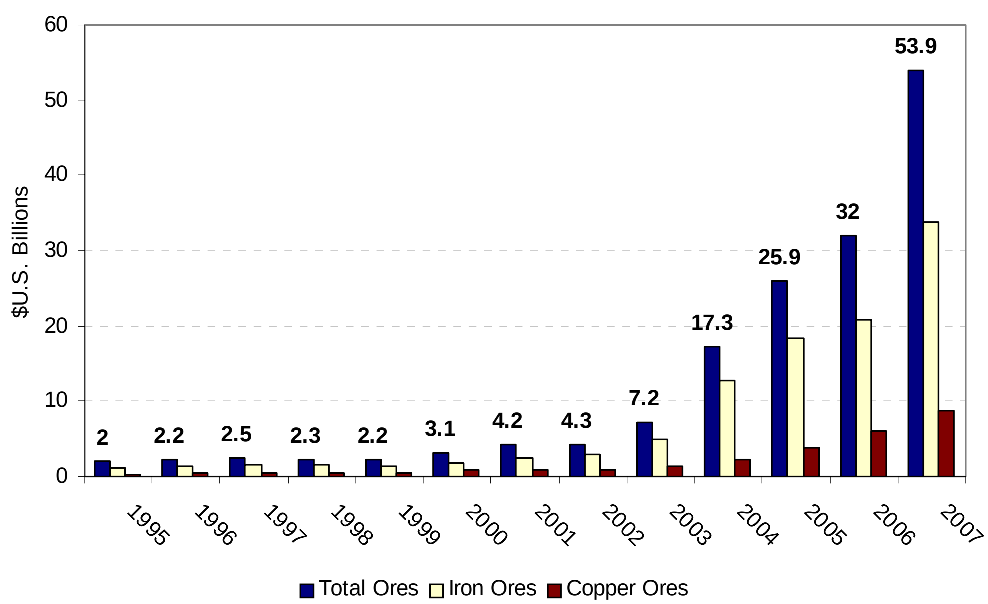
[44] For details on China's interests, see *China's Foreign Policy and "Soft Power" in South America, Asia, and Africa*, a CRS study prepared for the U.S. Senate, Committee on Foreign Relations (Washington, DC: GPO, April 2008).

sine qua non for economic growth.[45] Hence, China's government has urged its industries, particularly the state-owned enterprises, to "Go Global" to tie down secure sources of supply, and the state is facilitating their activities.

China also seeks some insulation from price spikes in raw materials needed by its burgeoning industrial sector. Its leaders are acutely aware of the fate of oil-poor countries, such as South Korea, who must buy their crude oil on open markets and, therefore, are exposed to sharp price increases. China has chosen to avoid excess reliance on spot markets by investing in exploration and development in countries with mineral deposits but lack the capital, technology, or infrastructure to exploit them.[46] It has been more successful in such investments in petroleum production than in iron or copper mining, but its large multinational enterprises have been active in seeking opportunities to secure stable sources of supply.

Figure 3 shows the value in U.S. dollars (at then-current exchange rates) of China's total imports of ores from 1995 to 2007, and China's two leading metal ore imports by value. In 1995, China imported a total of only $2 billion in mineral ores. By 2007 its imports had risen to $54 billion. The majority by value was iron ores and concentrates, which reached $38 billion in 2007. Imports of copper ores and concentrates had risen to $9 billion.

Figure 3. Chinese Imports of Selected Mineral Ores



Source: Data from *Global Trade Atlas*.

Figure 4 shows China's imports of iron and copper ores and concentrates in 1907 by major source country. Most of China's iron ore comes from Australia,

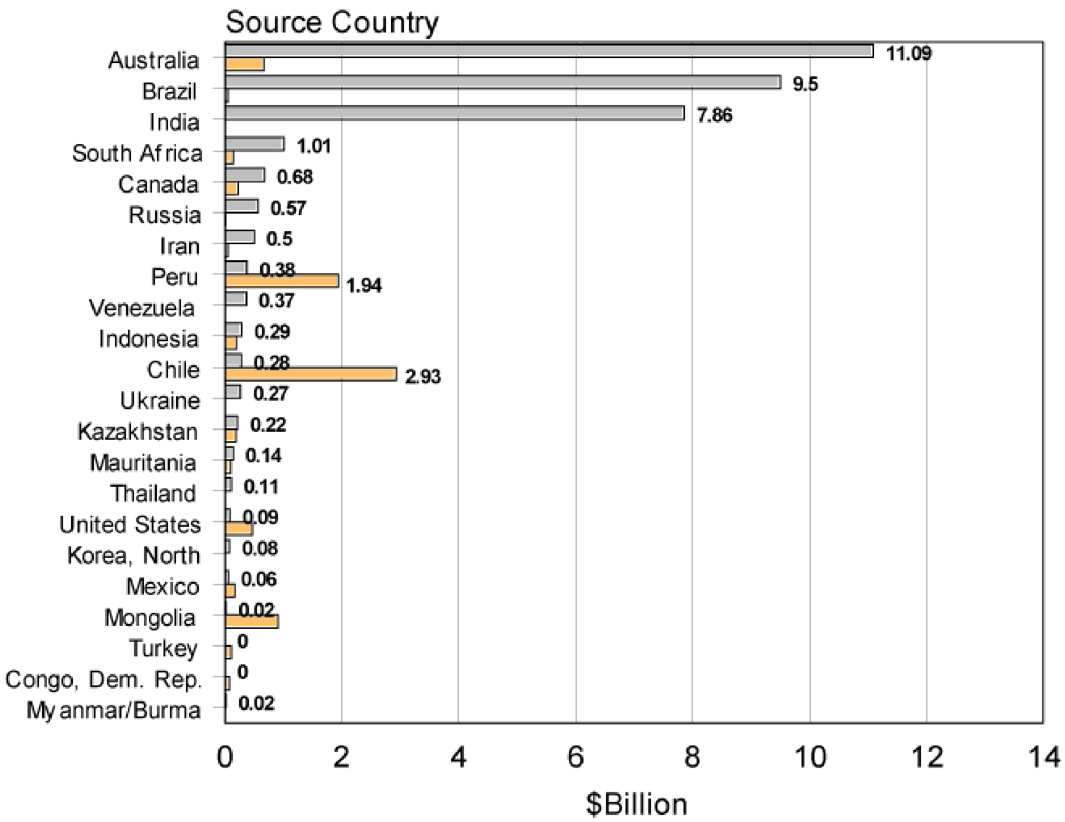
[45] Joshua Cooper Ramo, *The Beijing Consensus* (London: The Foreign Policy Centre, May 2004), p. 23.

[46] Matthew Forney, "China's Quest for Oil," *Time* (Internet version), October 18, 2004.

Brazil, and India. China also imports limited amounts from Iran, North Korea, and Burma — countries under U.S. trade sanctions. The major sources of copper ore for China are Chile and Peru with small amounts from Iran and the Democratic Republic of the Congo — the latter two being problematic countries for the United States.

In ore imports, China essentially is a price taker. It has had to pay the prices for iron ore, in particular, that have been negotiated between large steel companies in Japan and South Korea and the major ore producers, as detailed in a previous section of this report. It has argued, to date unsuccessfully, that lower shipping costs from Australia should be considered in the price it has to pay for Australian iron ore.

Figure 4. Sources of China's Imports of Iron and Copper Ores in 2007



Source: *Global Trade Atlas*.

Note: Includes ores and concentrates.

China's increasing demand for imports of minerals stems not only from the needs of its rapidly developing economy and a rising middle class that is demanding the accoutrements of modern life styles (including automobiles), but also from China's role as a manufacturing platform for the world. Everything from furniture to high-technology machinery are high users of iron and copper. China's exports of manufactured goods have transferred the required imports of raw materials from the consuming country (such as the United States) to China.

Attempts, such as China's, to secure sources of supply for minerals are not unusual in mineral extraction industries. Western multinational corporations in cooperation with host governments have long invested in exploration and development of promising oil fields or ore bodies. In 2006, for example, foreign affiliated companies accounted for 100% of metal mining production in countries as varied as Argentina in South America; Gabon, Ghana, Guinea, Mali, Tanzania, Zambia, and Botswana in Africa; and, Mongolia and Papua New Guinea in the Asia-Pacific region. Foreign affiliates also accounted for more than half the production in such large mineral-producing countries as South Africa, Namibia, New Caledonia, Indonesia, Colombia, Chile, Peru, and Kazakhstan. China has been a latecomer in these activities. In 2006, the top 25 metal mining companies involved in exploration projects did not include any from China.[47]

China's large state-owned enterprises often have the advantage of access to subsidized finance and investment insurance when investing overseas. This financial backing can enable them to assume greater risks in these investments. They also may be willing to pay a higher price for access to particular mineral resources. While most of the activity by Chinese companies has been in petroleum, the methods also could be used in investments in other mineral extraction projects. In 2006 in Angola, for example, China's Sinopec paid a reported $2.2 billion signature bonus in return for the right to explore for oil in two blocks.[48] Chinese companies also may be willing to invest in non-core businesses to secure control over production. In Nigeria in 2006, CNPC agreed to invest around $4 billion to revamp a refinery and construct a hydro power plant and a railway line in return for oil exploration and extraction licenses.[49]

Some of the promised Chinese investment in infrastructure, however, has not come to fruition. Chinese companies often are inexperienced in confronting the challenges of working in Africa or other developing nations. In Angola, for example, Chinese construction workers have dismantled their 16 camps built to restore the Lobito railway line, and a $2 billion contract has been canceled.[50] Some energy experts, moreover, state that China overpaid to buy into production from oil fields that already were mature and that Chinese companies are still learning what large foreign companies took a century to master.[51]

A key aspect of China's overseas investment policy is that it generally provides the funds without respect to human rights, economic sanctions, or other conditions that the host country must first meet. China also allows recipient countries to bypass the "red tape" and time delays associated with funding from international financial

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[47] United Nations Conference on Trade and Development. *World Investment Report 2007: Transnational Corporations, Extractive Industries and Development* (henceforth cited as UNCTAD, 2007).

[48] "Sinopec Said to Bid for Angolan Offshore Oil Field," *SinoCast China Business Daily News* (London) (May 12, 2006), p. 1.

[49] UNCTAD, 2007, p. 124.

[50] Serge Michel, "When China Met Africa," *Foreign Policy*, May/June 2008, p. 41-43.

[51] Matthew Forney, "China's Quest for Oil," *Time* (Internet version), October 18, 2004.

institutions. The President of Senegal reportedly made the following comment on Chinese funding,

> I have found that a contract that would take five years to discuss, negotiate and sign with the World Bank takes three months when we have dealt with Chinese authorities. I am a firm believer in good governance and the rule of law. But when bureaucracy and senseless red tape impede our ability to act — and when poverty persists while international functionaries drag their feet — African leaders have an obligation to opt for swifter solutions. I achieved more in my one hour meeting with President Hu Jintao in an executive suite at my hotel in Berlin during the recent G8 meeting in Heiligendamm than I did during the entire, orchestrated meeting of world leaders at the summit — where African leaders were told little more than that G8 nations would respect existing commitments.[52]

In essence, China is a new player in global mineral and energy markets. Its state-owned enterprises are well financed and eager to accomplish Beijing's plan to "Go Global." In many cases, the Chinese companies face severe competition from existing transnational corporations and have, consequently, ventured into countries where political risk is high and economic sanctions may be in force. Still, the vast majority of China's imports of minerals is purchased on the open market. The process of securing supplies of minerals, particularly those requiring new exploration and development, is long-term and costly.[53]

On the demand side, the Chinese people are abandoning their bicycles for cars, turning from agriculture to manufacturing, and developing a mineral-intensive lifestyle typical of other industrialized nations of the world. Nicholas Lardy, a specialist on the Chinese economy at the Peterson Institute for the International Economy, has stated that China uses three to five times as many primary products per unit of output as the amounts used in advanced industrial economies.[54] China's economy is expected to grow at about 8% over the near term. As its economy grows, demand for products that take mineral ores as raw materials inevitably will also grow.

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[52] Abdoulaye Wade, "Time for the West to Practise What It Preaches," *Financial Times* (January 24, 2008), p. 6.

[53] This CRS report does not cover allegations of China also seeking to reduce through government policies the exports of primary products, in order to keep them at home for use by domestic manufacturers. The Office of the U.S. Trade Representative is reportedly considering an international trade case against such Chinese policies, which may affect some of the minerals discussed in the next section. See *Financial Times* (*FT.com*), "U.S. to Challenge China over Steel Prices" (September 3, 2008); and *AMM*, "WTO Case May Target China's Export Barriers" (September 5, 2008).

[54] N. Lardy, presentation on China at Peterson Institute conference on "The Trillion Dollar Club" (September 23, 2008).

Metals Mineral Resources Availability[55]

U.S. mineral policies provide a framework for the development of domestic metal mineral resources and for securing supplies from foreign sources. Specifically, the Mining and Minerals Policy Act of 1970 (P.L. 91-631; 30 U.S.C. §21a.) declared that it is in the national interest of the United States to foster the development of the domestic mining industry "... including the use of recycling and scrap." The National Materials and Minerals Policy, Research and Development Act of 1980, among other things,

> declares that it is the continuing policy of the United States to promote an adequate and stable supply of materials necessary to maintain national security, economic well-being and industrial production, with appropriate attention to a long-term balance between resource production, energy use, a healthy environment, natural resources conservation, and social needs.[56]

This section reviews trends in mineral production and mineral prices over the past decade or so for a selected set of mineral commodities, and discusses possible reasons for the substantial price increase each commodity has experienced in the past few years. Within that context, the report examines the relationship between mineral prices and mineral production, and the consequences to the access and availability of the selected minerals essential to the United States. It focuses on the following minerals, which have major industrial significance:

- Iron ore
- Aluminum (bauxite/alumina)
- Copper
- Manganese
- Molybdenum (moly)
- Zinc
- Platinum group metals (PGMs)
- Uranium

The group of minerals listed above represent a broad spectrum of minerals used in the U.S. economy. They range from the United States being virtually 100% import-reliant (bauxite and manganese) to little import reliance (molybdenum and iron ore). They also represent a range of industry usage. For example, iron ore, manganese, and zinc are used for steelmaking; PGMs and aluminum are used in the transportation sector; and, uranium is used in the electric power sector and for nuclear weapons.

There has been a long-term policy interest in mineral import reliance and its impact on national security and the U.S. economy. In addition to examining the relationship between price, production, and availability, this report will briefly explore the concept of "criticality" as examined within the NRC 2008 report,

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[55] Prepared by Peter Folger and Marc Humphries of the Resources, Science, and Industry Division.

[56] P.L. 96-479; 30 U.S.C. §1601.

Critical Minerals, discussed earlier. Critical minerals are defined in the NRC report as those minerals that are both essential in use and subject to considerable supply risk. There is also considerable congressional debate over how best to reform the General Mining Law of 1872 (30 U.S.C. 21-54) and how that reform might relate to domestic mining capacity on U.S. public lands.

This section also provides some discussion of the U.S. reliance for minerals on one or two dominant producers, or dominant producing countries (having the bulk of reserves or production capacity), which could be a cause of concern when it comes to reliable and secure mineral supplies.

Mineral Commodity Analyses

Iron Ore. Nearly all iron ore is used for steelmaking. World production of iron ore is expected to continue to increase as a result of increasing global demand for steel. Despite actual and planned production output increases, domestically and abroad, iron ore prices have risen dramatically.

The United States directly produces and consumes about 3% of world iron ore supply. U.S. iron ore average annual prices nearly doubled from $32/MT(metric tons) in 2003 to $63/MT in 2007, compared to $28-$32 per MT during the late 1990s.[57] As discussed earlier, prices continued to rise in 2008, and further increases are expected in 2009. Iron ore production in the United States generally declined from more than 60 million MT in the mid-1990s, to 58 million MT in 1999, and 46 million MT in 2003. Then it rose marginally to 52 million MT by 2007. The United States in 2007 was essentially self-sufficient in iron ore with both imports and exports of about nine million MT. Imported iron ore has declined since 2003 as a share of consumption, as world prices increased and some closed U.S. mines have been reopened.

World production has increased significantly (nearly double) since 1998, from a range of 1-1.2 billion MT in 2003, to 1.9 billion MT in 2007. Major world iron ore producers include China, Brazil, Australia, India, and Russia. Together, they account for 82% (1.56 billion MT) of 2007 world output. About 72% of world reserves are located in Ukraine, Russia, China, Brazil, and Australia (in descending order of quantities). China is the world's leading iron ore producer and importer, increasing production from 310 million MT in 1998 to 600 million MT in 2007.

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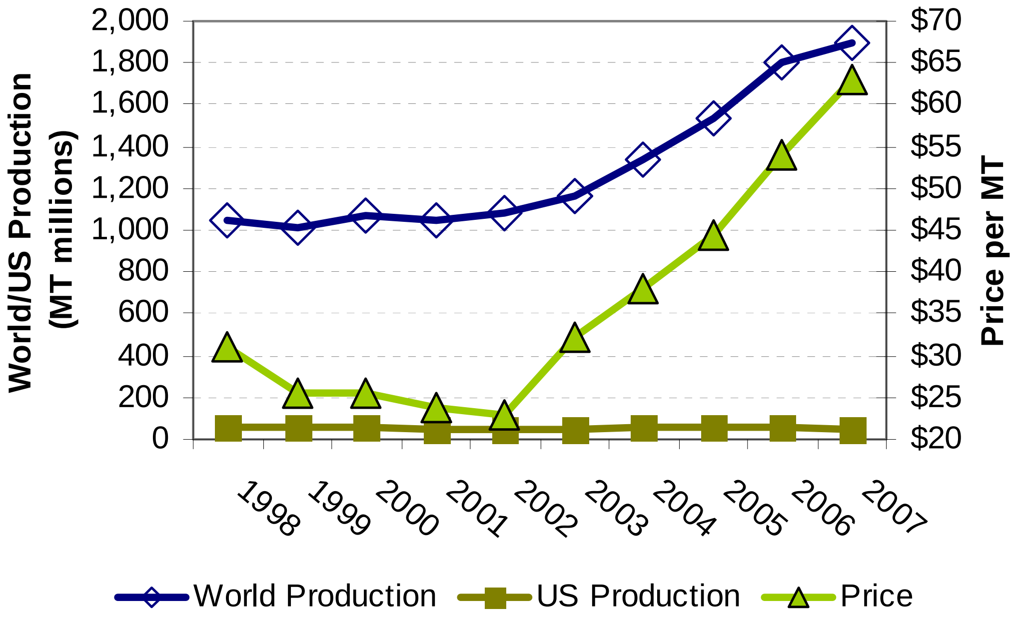
[57] All data under this subhead are from USGS 2007-08 sources (*Minerals Commodity Summaries* and *Minerals Yearbooks*), unless otherwise identified.

Figure 5. Iron Ore Production and Price



Source: USGS *Mineral Commodity Summaries*, various issues.

World mine capacity is expanding, but not as fast as demand, according to the USGS, causing a global supply shortage.[58] U.S. producers are evaluating the expansion of lower grade deposits but are faced with similar constraints as other producers, such as the lack of skilled workers, shortages of capital equipment, and higher transportation costs. In the United States, twelve mines (located in northern Minnesota and northern Michigan) are operated by three companies: Cleveland Cliffs, ArcelorMittal Steel, and U.S. Steel Corporation. There are eight concentrate plants and eight pelletizing plants (taconite) in the United States. Investment in downstream pelletizing and nugget facilities is taking place, and the United States is among the highest in world pelletizing capacity.[59] A possible merger between RioTinto and BHP of Australia has raised concern over the global supply and price for iron ore since the companies are two of the world's three leading producers. Together they control about 15% of the world iron ore mine capacity.

Aluminum (Bauxite/Alumina). Bauxite is the raw material that is transformed into alumina (an intermediate product) before being processed into aluminum. About 85% of world bauxite production is used to make alumina.[60] The United States produces a negligible amount of bauxite for making alumina, and the USGS rates U.S. alumina producers as 100% reliant on bauxite imports. Domestic aluminum end-use consumption is primarily in the transportation (38%) and packaging (22%) sectors.

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[58] USGS, *Mineral Commodities Summaries* (2008), p. 94. But note earlier comments by industry analysts cited in this CRS report who believe this situation may be changing.

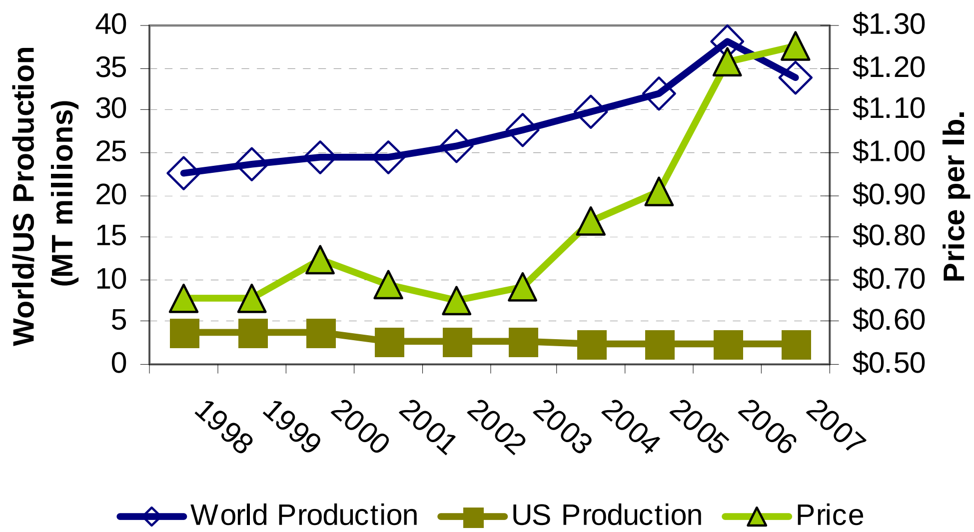
[59] USGS, *Minerals Yearbook*, vol. I, 2005.

[60] USGS, *Minerals Yearbook*, vol. I, 2006.

Prices for bauxite rose from $19/MT in 2003 to $27/MT in 2007, and even higher in 2008.[61] Prices increased despite growth in world production from 146.0 million MT in 2003 to 190.0 million MT in 2007. Leading producers, accounting for 85% of total production are Australia, China, Brazil, Guinea, India, and Jamaica, in descending order. World production has risen steadily since 1998 with much of the increase coming from Brazil, China, and Australia. About 68% of bauxite reserves are located in four countries: Guinea, Australia, Jamaica, and Brazil.

In 2007, the United States received 80% of its bauxite imports from Jamaica (45%), Guinea (20%), and Brazil (15%). North American aluminum producers Alcan and Alcoa are heavily invested in alumina and bauxite production worldwide. Because of consistent investment in global bauxite mine capacity and alumina refineries, diversity of supply, and huge bauxite reserves, supplies of bauxite and alumina are likely to be sufficient over the long term.

Figure 6. Aluminum Production and Price



Source: USGS *Mineral Commodity Summaries*, various issues.

Transportation and packaging dominated the end use sector in the 1990s as well. But U.S. consumption has declined since the late 1990s from 7.5 million tons to 5.3 million tons in 2007. According to USGS aluminum analyst Lee Bray, the downturn in U.S. aluminum consumption over the past several years is the result of a reduction of manufactured goods produced in the United States that use aluminum, such as auto parts and "white goods" (home appliances). More of these products are imported, and thus, the aluminum consumption is recorded where the products are manufactured, not necessarily where the products are used.[62]

Primary aluminum production in the United States, which had been as high as 3.7 million MT in 1998, declined from 2.7 million MT in 2003 to 2.3 million MT in

[61] USGS, *Mineral Commodity Summaries*, various years.

[62] CRS communication with Lee Bray, Aluminum Specialist, USGS, August 2008.

2006, then rose again to 2.6 million MT in 2007.[63] During the first few months of 2008, U.S. aluminum production continued to rise, as did exports, although U.S. demand declined. U.S. aluminum net import reliance stayed between 20%-30% in the latter half of the 1990s, then rose to as much as 45% in 2005 amid U.S. industry production declines. Net import reliance has since declined again to 26%. Most imports (55%) are from Canada.[64]

Changes in aluminum prices partly reflects the increase in bauxite prices. The average annual price for aluminum increased from $0.68 per pound (lb.) in 2003 to about $1.25 per lb. in 2007. By mid-July 2008, the average weekly price per pound was $1.46.[65] Refining aluminum requires large amounts of energy, such much of this price increase may also be explained by higher energy costs.

By contrast to U.S. production fluctuations, world aluminum production rose by more than 70% from 22.1 million MT in 1998 to 38.0 million MT in 2007. There are currently about 4.7 million MT of excess world capacity, including about 1.1 million MT of excess aluminum capacity in the United States, despite prices rising so dramatically in the past few years. Most aluminum capacity is in China (14 million MT), with Russia (4.4 million MT) and the United States (3.7 million MT) a distant second and third respectively.[66] China and Russia have expanded capacity and production since 2003. Some metals analysts believe that China may face aluminum production constraints as a result of electric power shortages, but they also note that current high inventories may minimize the effect of any supply cutback.

Increasing world demand for aluminum has generated interest in more planned aluminum capacity and the restarting of idle capacity. Experts predict that aluminum supplies should be ample in the foreseeable future, but making aluminum is energy intensive, as noted above. This results in high production costs. Should prices fall significantly, many high-cost producers may cut back on production.

Copper.[67] Approximately half of the copper and copper alloy products produced in the United States is used in the building and construction industry; approximately 20% is used in the electric and electronic industry; and transportation equipment, consumer and general products, and industrial equipment and machinery account for approximately 10% of copper consumption each.

The average annual price for copper ranged between $0.72 per pound and $0.84 per pound from 1998 to 2003, rising to $1.29 per pound in 2004 and to $3.29 per pound in 2007 (see **Figure 7**). As of June 16, 2008, the price of copper was $3.71 per pound, nearly five times its value in 1998 (in nominal dollars not adjusted for inflation).

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[63] USGS, *Mineral Commodity Summaries*, various years.

[64] USGS, *Mineral Commodity Summaries*, various years.

[65] *Metals Week* average transaction price July 21, 2008.

[66] USGS, *Mineral Commodity Summaries*, various years.

[67] Production, import, export, price, and usage data from USGS, "Copper Statistics and Information," at [http://minerals.usgs.gov/minerals/pubs/commodity/copper/].

Annual U.S. mine production of copper was 1.86 million MT in 1998, and declined each year to a low of 1.14 million MT in 2003, before stabilizing and rising slightly to 1.19 million MT in 2007. Mines in five states produce 99% of the U.S. copper mined each year: Arizona, Utah, New Mexico, Nevada, and Montana. In 2007, 17 of the 26 mines operating accounted for 99% of the copper produced in the United States.

Annual world production (not including U.S. production) has risen each year since 1998 except in 2002 and 2003. Annual global mine production of copper was 12.1 million MT in 1998, and 15.6 million MT in 2007, an increase of 22% over the 10-year period. As a percent of total world production from mines, annual U.S. production has ranged from a high of 15.4% in 1998 to a low of 7.6% in 2005, and was still about the same share in 2007.

Except for 2002-2003, the total sum of global copper mine production (including the United States) has increased each year over the past 10 years, and as of 2007 was 16.9% greater than in 1998. Chile is the world's leading copper producer from mines, responsible for approximately 5.7 million MT in 2007, approximately 37% of global copper production, and nearly five times that of the United States.

China is the world's leading copper consumer. If Chinese demand for copper continues at current levels or increases, copper prices are likely to remain high until production from existing and new mines in the United States and elsewhere begins to catch up. The recent slump in the U.S. housing market is likely to decrease domestic demand for copper from the building and construction industry, which could also affect prices.

In response to persistent global demand for copper, particularly from China, some commodity analysts have concluded that planned copper production at mines will increase both in the United States and abroad.[68] New projects in Minnesota, Montana, and Arizona may add 240,000 MT of new mine capacity in the United States by 2009, which would increase U.S. production by 20% over 2007 levels, and could ease tight supplies which are contributing to high copper prices. However, copper production from mines often lags behind spikes in demand and higher prices; for example, U.S. copper production from mines has increased by 5.9% since 2003 even though the price for copper has quadrupled over the same time period. Labor and equipment shortages at U.S. copper mines have constrained production, which affects supply and prices. However, U.S. copper reserves and anticipated new mine production are both likely to be large enough to meet domestic demand over the longer term.

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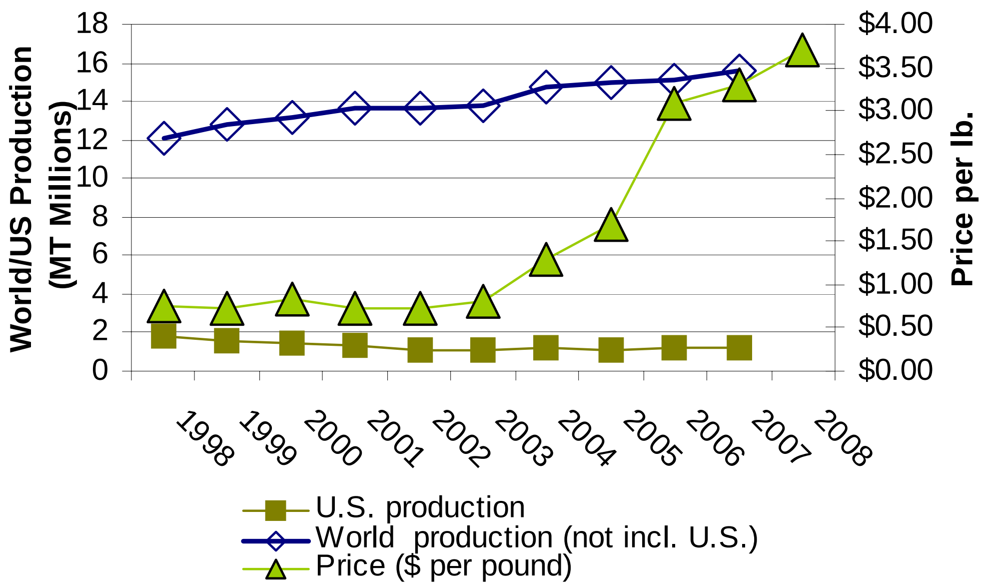
[68] International Copper Study Group, "Forecast 2008-2009," (April 28, 2008); at [http://www.icsg.org/].

Figure 7. Copper Production and Price



Source: USGS Copper Statistics and Information, at [http://minerals.usgs.gov/minerals/pubs/commodity/copper/].

Note: Year 2008 price as of June 16, 2008.

The rapid increase in copper prices suggests that an increase in demand, as opposed to a drop in supply from producing mines, has been the primary force driving the higher price of copper since 2003. Fluctuations in price may reflect changes in the short-term availability of copper, either from stocks or other sources of refined or recycled copper. Resources of copper available to mine, both in the United States and abroad, are likely sufficient to meet foreseeable global demand, even in view of China's economic expansion.

However, industry analysts identify a key factor, known as *mine capacity utilization* — the ratio of total production to annual production capacity — which has hindered the production of copper from mines and has likely affected copper prices, which, as seen in **Figure 1** earlier, have risen more steeply than any other mineral prices. Labor unrest, adverse weather, and shortages of skilled labor, electricity, and other raw materials and supplies, all contribute to lower the mine capacity utilization rate so that actual mine output does not match planned output. According to industry analysts, global mine capacity utilization averaged roughly 90% from 2002 to 2007, a reasonably high rate. It declined to 82% during the first quarter of 2008.[69] Thus, while copper production from planned mine expansions and new mines, both in the United States and abroad, may theoretically ease tight supplies in the near future, unknown disruptions to mine production may contribute to lower than anticipated mine capacity utilization and continued high copper prices.

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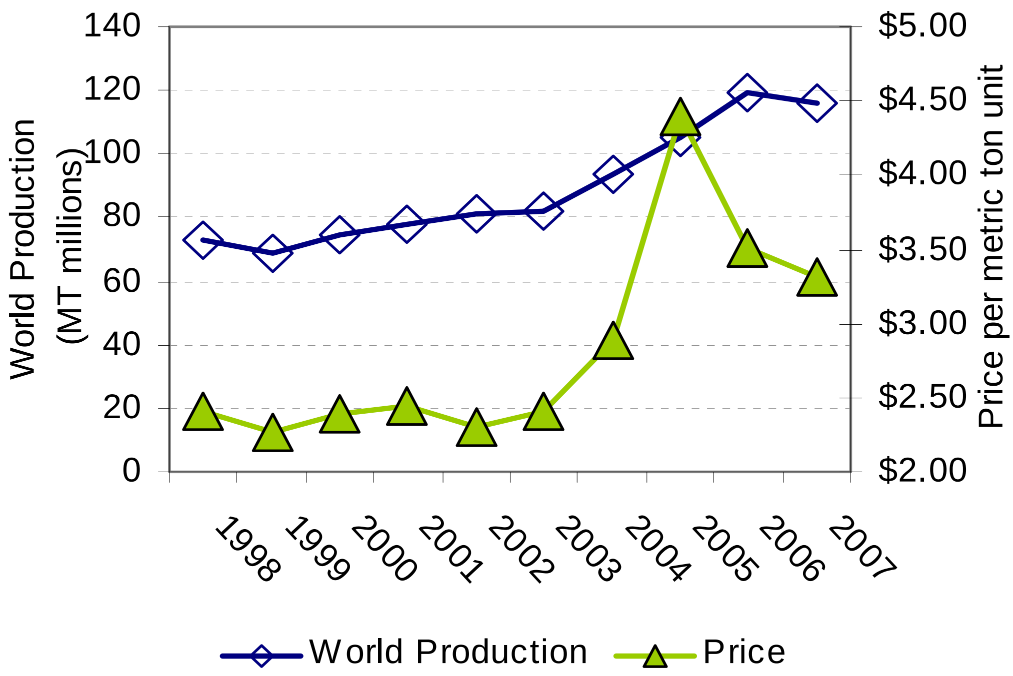
[69] International Copper Study Group.

Manganese. Manganese is essential to making steel (it hardens the steel) and demand is directly related to steel production (derived demand). Manganese is also used in the construction, machinery, and transportation sectors.

The average annual price for manganese ore increased from $2.41 per metric ton unit (mtu)[70] in 2003 to $3.32 /mtu in 2007, after peaking at an average annual price near $4.50/mtu in 2005. The USGS reports prices as high as $8.65/mtu in 2007 (as the average spot market price). Because of high demand from India and China, and high ocean transportation costs, metals analysts forecast manganese ore prices (44-48% manganese content) to be in the $9/mtu-$13/mtu range in 2008. It is unclear what impact the recent price run-up will have on U.S. demand.

Figure 8. Manganese Production and Price



Source: USGS *Mineral Commodity Summaries*, various issues.

The top five producing countries (South Africa, Australia, China, Gabon, and Brazil) account for 75% of world production (8.65 million MT). Manganese ore reserves are dispersed in significant quantities around the world. But South Africa, Ukraine, and Australia hold about 75% of world manganese reserves. Other countries with significant reserves include Brazil, China, India, and Gabon. World production of manganese ore rose from 7 million MT in 1998 to 11.6 million MT in 2007, a 66% increase.[71]

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[70] The "mtu" is a volume measure related to mineral content — 44%-48% manganese content is the usual standard.

[71] USGS, *Mineral Commodity Summaries*, various years.

The United States produces no manganese, thus is 100% import-reliant. Some ferromanganese is produced at two U.S. smelters, although production data are proprietary and not publicly available. About 65% of U.S. manganese ore imports are from Gabon. Also, the United States imports a considerable amount of ferroalloys processed from manganese (ferromanganese and silicomanganese) primarily from South Africa (51%). Imports of ferroalloys have been consistently more than 300,000 MT since the 1990s. There are supply risks associated with manganese because of its importance to the U.S. steel market and lack of substitutes, and the United States will likely remain 100% import-reliant on manganese for years to come. However, because of the diversity of ore and alloy producers, the supply risk may be minimal.[72]

Molybdenum.[73] Molybdenum (often shortened to "moly") is used principally as an alloying agent in cast iron, steel, and other metal alloys to increase hardness, strength, toughness, and resistance to corrosion and wear. The steel manufacturing industry is a significant consumer of moly, for example. Domestically, iron, steel, and other alloy producers account for approximately 80% of annual U.S. moly consumption. Moly is also used in catalysts, lubricants, and pigments. Some commodity experts indicate that consumption of moly by the steel industry, particularly in China, is a major driver underlying the change in moly price over the past five years.

The average annual price for molybdenum in metal form rose was less than $5 per pound in 2002, and slightly more than $5 per pound early in 2003. Then the price escalated to more than $16 per pound in 2003, and has been more than $25 per pound since 2004 (see **Figure 9**). As of June 9, 2008, the price for moly was $33.20 per pound,[74] over 12 times its value in 1998 (in nominal dollars not adjusted for inflation). Annual U.S. production of moly concentrate from mines and mills was more than 53,000 MT in 1998, and decreased to a low of 32,300 MT in 2002. Annual production in the United States has risen since 2002 to more than 58,000 MT between 2005 and 2007. Annual world production (not including U.S. production) has also increased since 2002, from 89,700 MT to 127,600 MT in 2007. As a percent of world production, annual U.S. production in the past decade started at 39.2% in 1998, and fell to to a low of 26% in 2003. In 2007 the U.S. produced 32% of the world's moly concentrate from mines.

With the exception of two years — 2002 and 2006 — the total sum of global production of moly from mines has increased every year over the past 10 years, and as of 2007 was 37% greater than in 1998. The rapid increase in the moly price suggests that an increase in demand, even while both global and U.S. production increased, has primarily been driving the higher price since 2003.

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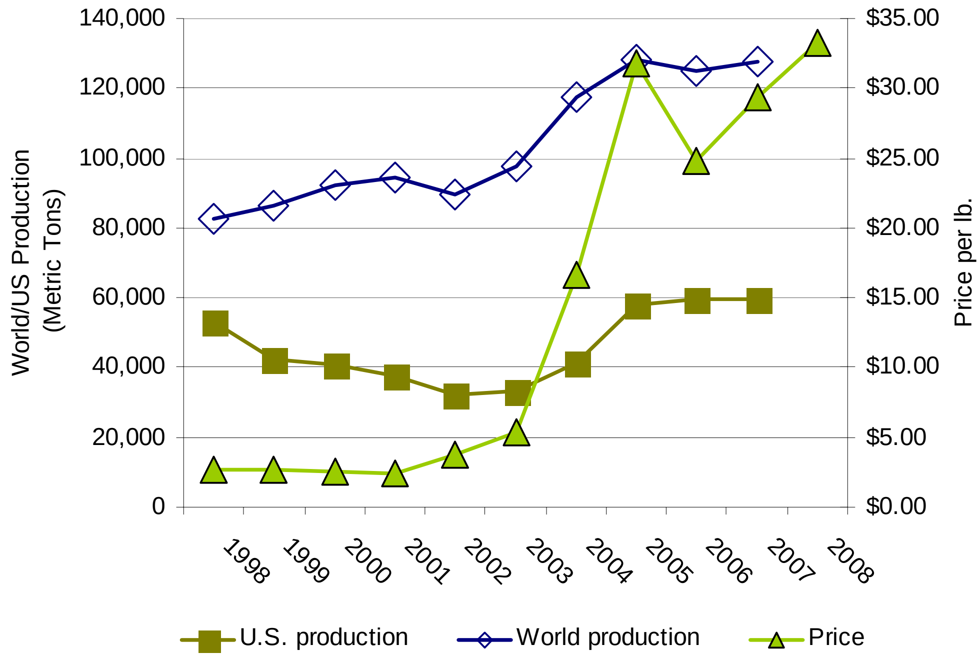
[72] USGS, *Mineral Commodity Summaries*, various years.

[73] Production, import, export, price, and usage data from USGS, "Molybdenum Statistics and Information," at [http://minerals.usgs.gov/minerals/pubs/commodity/molybdenum/].

[74] *Platts Metals Week* (June 9, 2008), p. 20.

Figure 9. Molybdenum Production and Price



Source: USGS Molybdenum Statistics and Information, at [http://minerals.usgs.gov/minerals/pubs/commodity/molybdenum/].

Note: Year 2008 price as of June 16, 2008.

The United States produces more moly ore from mines than any other country, and is second only to China in identified moly reserves. The U.S. reserves of moly are large enough to meet anticipated domestic demands in the foreseeable future: from the four existing mines that produce moly as a primary product,[75] and from the five copper mines that produce moly as a byproduct.[76] In addition, the giant Climax moly mine near Leadville, Colorado, which has been inactive since 1995, is reportedly preparing to resume open pit mining and could become the leading U.S. moly producer by 2010.[77]

Mines often are unable to increase production quickly enough to meet increases in demand, which may explain some of the recent price increase, and which could contribute to a further rise in moly prices. Also, some commodity specialists identify moly "roasting" plants as a possible bottleneck to increased moly production.[78] Molybdenum concentrate produced from a mine is "roasted" in plants to convert

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[75] One mine each in Colorado, Idaho, Nevada, and New Mexico.

[76] Two mines in Arizona, one each in Montana, New Mexico, and Utah.

[77] The Climax mine might produce as much as 15,000 MT of moly per year beginning in 2010, over one-fifth of current U.S. annual production. *Rocky Mountain News*, "Climax Back in Business" (December 5, 2007).

[78] Michael J. Magyar, USGS Mineral Commodity Specialist, CRS interview (June 20, 2008).

molybdenite (molybdenum disulfide, or MoS_2) concentrate to an oxide, which is then used to produce intermediate products such as ferromolybdenum, metal powder, and various chemicals. Domestic roasting plants operated at full production capacity in 2006 and 2007. Thus, the anticipated increase in moly production from existing and new mines in the United States could exceed the ability of U.S. roasting plants to process the ore. This capacity shortfall could limit the delivery of moly intermediate products to the market or result in increased U.S. exports to roasting facilities in other countries. A roasting plant bottleneck could have an effect on moly prices if demand continues to increase.

Zinc.[79] Zinc is primarily used for galvanizing, the process in which zinc is applied as a coating to protect steel from corrosion, which accounted for 55% of the zinc consumed in the United States in 2007. Approximately 20% of zinc is consumed in zinc-based alloys, 16% consumed for manufacturing brass and bronze, while less than 10% is consumed for other uses in the United States. Globally, China is the leading consumer of zinc (approximately 30% of global consumption), and the United States is the second largest consumer (approximately 10%).

The average annual price for zinc metal ranged from $0.35 to $0.51 per pound between 1998 and 2004, rose to a peak of $1.51 per pound in 2007, and dropped to $0.91 per pound as of June 9, 2008 (see **Figure 10**). Spot prices rose briefly above $2 per pound in November 2006, declined but rose again to approximately $1.75 per pound in May 2007, and have declined to below $0.90 per pound as of June 20, 2008.[80]

Annual U.S. production of mined zinc ore concentrate was relatively constant between 1998 to 2007, averaging approximately 781,000 MT per year, reaching a maximum of 852,000 MT per year in 2000 and a minimum of 727,000 MT per year in 2006. Annual world production (excluding U.S. production) has risen each year since 1998, from 6.82 million MT to 9.76 million MT, an increase of 30% over the 10-year period. As a percent of world mine production, annual U.S. zinc production from mines has decreased from about 10% in 1998 to about 7% in 2007. Zinc is mined in the United States in seven states, with Alaska, Missouri, Montana, and Washington accounting for 99% of total mine output. A single mine, the Red Dog Mine in northwest Alaska, accounts for 77% of the entire U.S. mine production, and is the world's single largest producer of zinc concentrate.

Globally, China produces more zinc ore concentrate than any other country, followed by Peru, Australia, and the United States. China produced 2.8 million MT of zinc from mines in 2007. This was approximately one quarter of the global zinc production from mines, and 3.8 times the U.S. mine production.

With the exception of 2001-2002, global production of zinc from mines (including the United States) has risen each year since 1998. The rapid increase in the average annual price of zinc, beginning in 2003 and peaking in 2007, suggests

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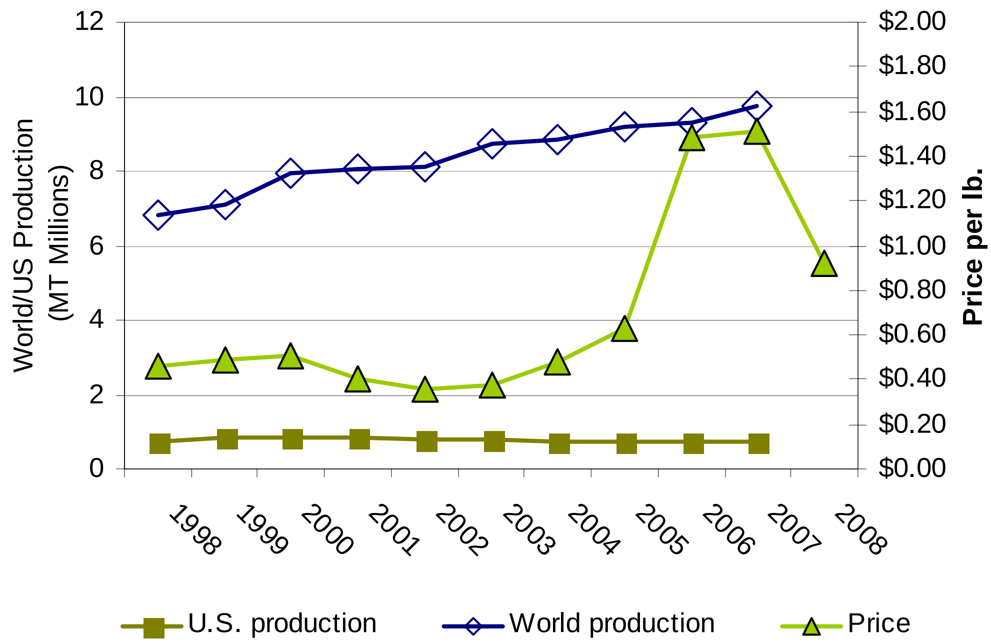
[79] Production, import, export, price, and usage data from USGS Zinc Statistics and Information, at [http://minerals.usgs.gov/minerals/pubs/commodity/zinc/].

[80] London Metal Exchange, at [http://www.lme.co.uk/zinc_graphs.asp].

that an increase in demand, as opposed to a decrease in supply from producing mines, was primarily driving the higher price. From 2004 to 2006, consumption of zinc outpaced production, causing a decline in zinc stocks accompanied by a rise in price.[81] Some analysts suggest that the gap between production and consumption resulted from industry underinvestment in exploration and mine development while the market had a surplus supply of zinc.[82] In 2007, a surge in mine production, resulting from mine reopenings and new mine commissioning in 2006, outpaced an increase in zinc consumption. The resulting surplus of zinc supply over zinc consumption has likely caused prices to drop since 2007 (see **Figure 10**).[83]

Figure 10. Zinc Production and Price



Source: USGS Zinc Statistics and Information, at [http://minerals.usgs.gov/minerals/pubs/commodity/zinc/].

Note: Year 2008 prices as of June 16, 2008.

Zinc ore production was forecast to increase in the United States in 2007 and 2008, due in part to the reopening of several zinc mines in eastern Tennessee that closed earlier because of low zinc prices. Global zinc production was also forecast to continue increasing through 2008, owing to increased mine production in several countries in addition to the United States. If production and consumption trends continue as expected in 2008, the resulting net surplus of zinc will likely keep zinc

[81] Amy C. Tolcin, USGS Mineral Commodity Specialist, communication to CRS (June 24, 2008).

[82] *Ibid.*

[83] The question of the impact of the major 2008 earthquake in a zinc-producing region in China was addressed in the first part of this report.

prices from spiking again to 2007 levels. In fact, as noted earlier in the price overview section of this report, falling zinc prices in 2008 had led to consideration of closure of some U.S. mines.

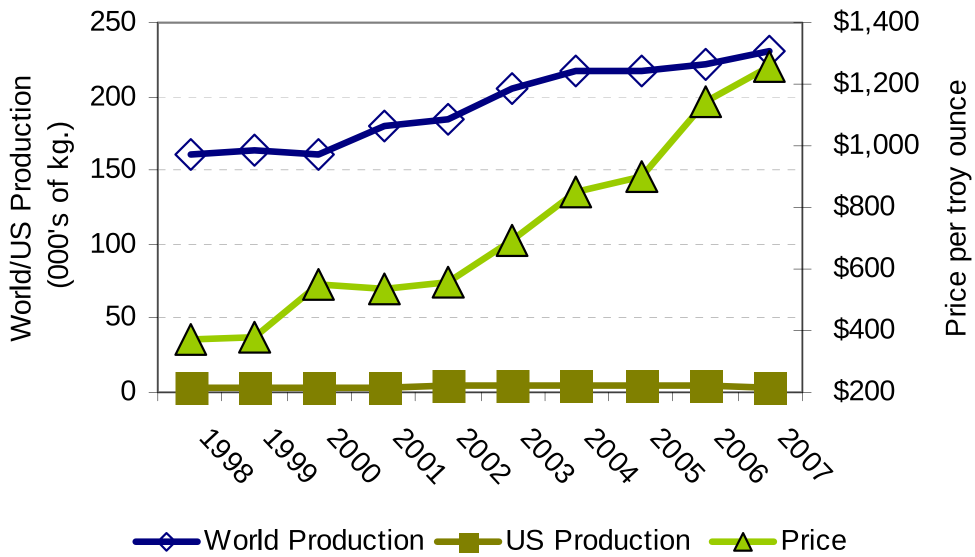
As with copper and moly, reserves of zinc are likely sufficient to meet foreseeable global demand driven primarily by expansion of the Chinese economy. Factors other than the amount of zinc available to mine (discussed above), both in the United States and abroad, constrain zinc production in the short term, affecting prices particularly since 2004. As with copper and moly, a short-term increase in demand is not immediately met with increased production from existing mines or from new mines, which could result in a short-term tight supply, as occurred between 2004 and 2007. In the future, zinc production would likely lag a short-term increase in demand until existing mines are reopened or new mines begin producing, or sufficient stockpiles of zinc concentrate are available to meet short-term surges in demand.

Platinum Group Metals (PGMs). The platinum group metals are platinum, palladium, rhodium, ruthenium, iridium, and osmium. They have excellent oxidizing catalytic properties. For that reason, the global auto industry has become a major end user of PGMs, especially platinum and palladium, for catalytic converters that reduce air emissions. Catalysts for pollution control lead the consumption categories for PGMs, and this report will focus on platinum in particular. As standards become more stringent worldwide, both platinum and palladium will likely continue to be in high demand. Platinum may be used more in diesel engines, while more palladium can be used in gasoline engines. PGMs are also used for catalysts in the chemical industry, for the fabrication of laboratory equipment, and for jewelry.[84]

The United States is 94% import-reliant for platinum and about 73% import-reliant in palladium. The United States imports 44% of its unwrought platinum from South Africa, but also receives significant fabricated and secondary supply from the United Kingdom and Germany. The United States does produce a small amount of platinum at one mine in Montana. That same mine also produces more palladium than platinum. Since 1998, U.S. platinum production steadily grew from 3,240 kilograms (kg) to about 4,300 kg in 2006, but dropped to 3,400 kg in 2007. Annual imports of platinum have risen almost 50%, from 97,000 kg in 1998 to 140,000 kg in 2007.

[84] USGS, *Mineral Commodity Summaries*, 2008.

Figure 11. Platinum Production and Price



Source: USGS *Mineral Commodity Summaries*, various issues.

World production of platinum grew from 146,000 kg to 230,000 kg between 2003 and 2007. South Africa dominates global platinum production, accounting for nearly 80% of the total. Russia produces nearly 12% of world platinum production. World palladium production is dominated by the same two countries, each producing about 40% of the world total. Russia and a third producer, Canada, produce much of their palladium as a co-product or byproduct of nickel, cobalt and copper production. South Africa alone contains 89% of world PGM reserves (63 million kg).

Platinum, traded as a precious metal, was $372.50 per ounce (oz.) in 1998. The average annual price for platinum rose from $695/oz. in 2003 to $1,260/oz. in 2007. The July 2008 New York Mercantile Exchange (NYMEX) weekly average price for platinum was $1,990/oz., almost triple the 2003 price.

Supply disruptions in platinum mining took place in South Africa because of a shortage of electric generating capacity, which resulted in power outages throughout the country in 2008. Some platinum mine shut-downs and slow-downs have followed. Electric generating capacity could be a problem going forward because many believe that South Africa's electric capacity is inadequate. A state-owned utility company, Eskom Holding Ltd., has requested that mine producers curtail their use of energy to 90% of normal use. Some platinum producers may curtail expansions because Eskom cannot guarantee electric power for full operations. In Zimbabwe, some platinum operations are on hold because of the political turmoil there, but others in Zimbabwe, including those of Chinese companies and Anglo Platinum, a major producer, are expected to move forward with platinum mining projects. In Russia, severe weather and shipment delays have led to supply disruptions of palladium and platinum.

There is a great deal of supply risk and vulnerability for U.S. auto manufacturers and most other end users of PGMs (particularly platinum and rhodium) because of the reliance on South Africa as the primary source of platinum, because producers in that country have been shown to be vulnerable to supply disruptions. Although the requirements of PGMs in catalytic converters may be reduced to decrease the per unit demand, there are no substitutes that could replace PGMs entirely. Secondary recovery operations in the United States have increased but may not keep pace with increasing consumption to make a significant impact on import reliance. As a result of high platinum costs, imports of platinum scrap have increased from about 5,700 kg in 2003 to 39,400 kg in 2007.[85]

Uranium.[86] Unlike base metals such as copper, moly, and zinc, which are used primarily in manufacturing, the primary commercial use for uranium is in nuclear reactors to generate electricity. According to some industry experts, the cost structure of nuclear power generation — high capital costs and low fuel costs — has traditionally made it easier to predict demand for uranium than for other commodities.[87] Demand forecasts have thus largely depended on installed and operable capacity, regardless of short-term economic fluctuations.[88]

In the absence of a spike in demand in the past two years, some industry observers attribute the spike in the spot price for uranium in 2007 to a perception of scarcity,[89] perhaps due to the exhaustion of stockpiled uranium held by utilities, even though global uranium production from mines has remained relatively constant since 2003. Other factors, such as continued economic growth in China and increasing electricity demand, as well as concerns about the greenhouse gas emissions of coal- and natural gas-fired electricity plants, may also lead to a perception of uranium scarcity amidst higher demand. An analysis of the factors influencing uranium prices is beyond the scope of this report; however, the rise in uranium prices has sparked interest in developing new U.S. uranium resources. Renewed interest in developing new uranium mines or reopening shuttered mines has also raised concerns about access to uranium deposits on both public and private land, and concerns about possible environment consequences of a reinvigorated uranium mining industry. Note especially the controversy, discussed below, about mining near the Grand Canyon.

Like copper, moly, and zinc, and the other metals discussed above, the average annual price for uranium has risen substantially in the past few years (see **Figure 12**). Unlike copper and zinc, which are widely traded and priced on formal commodity exchanges, such as the London and New York Metal Exchanges, uranium is mostly traded through direct contracts between buyers and sellers, and price indicators are

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[85] USGS, *Mineral Commodity Summaries*, various years.

[86] Production and price data from the U.S. Dept. of Energy. Energy Information Administration (EIA), "Official Energy Statistics From the U.S. Government," at [http://www.eia.doe.gov/fuelnuclear.html].

[87] World Nuclear Association, at [http://www.world-nuclear.org/info/inf22.html].

[88] World Nuclear Association, at [http://www.world-nuclear.org/info/inf22.html].

[89] World Nuclear Association, at [http://www.world-nuclear.org/info/inf22.html].

developed by a small number of private businesses.[90] Contracts can be spot-market contracts, usually a one-time delivery of an entire contract within a year of the contract signing date; or they can be short-, medium-, or long-term contracts, with one or more deliveries occurring after one year of contract signing.[91] The distinction is important because the average annual weighted-average price[92] for uranium rose sharply between 2006 and 2007 from approximately $18 per pound to over $30 per pound; however, the spot-market price peaked at over $130 per pound between June and July, 2007.[93] According to one price indicator, the uranium spot market price has dropped since the 2007 peak, and as of June 16, 2008, was approximately $56 per pound.

Uranium mining and production has been a cyclical industry in the United States, with production of uranium linked to its price. The last price spike for uranium occurred in the mid 1970s and early and mid 1980s, after which prices fell and remained relatively low throughout the 1990s, bottoming out at approximately $10 per pound in 2001 (not adjusted for inflation). Over the past 10 years, U.S. production of uranium from mines and mills has averaged about 3.4 million pounds per year, with a low of two million pounds per year in 2003, and a high of 4.7 million pounds per year in 1998. U.S. production has increased each year since 2003, and in 2007 was 4.5 million pounds per year, more than double the amount produced in 2003. Most of the uranium purchased in the United States is imported, however. U.S.-produced uranium accounted for less than 10% of U.S. purchases in 2007 (see **Figure 12**).

The rise in uranium prices over the past several years has led to an increase in exploration activities for new sources of uranium in the United States. Uranium exploration and development drilling increased in 2007 by 90% over 2006 levels: a total of 9,347 boreholes drilled for a combined length of 5.1 million feet, 2.4 million feet (89%) more than in 2006.[94] Employment in the exploration sector for uranium doubled from approximately 200 person-years in 2006 to 400 person-years in 2007. Exploration employment was below 100 person-years in 2005.[95] In addition to mining industry statistics, news reports in the past year have pointed to the rise in uranium mining claims on public lands in western states as an indicator of renewed interest in uranium mining. For example, the *Durango Herald* reported a rise in

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[90] See, for example, the price index developed by the UX Consulting Company, LLC, at [http://www.uxc.com/index.aspx]. Uranium futures contracts are also provided via the New York Mercantile Exchange (NYMEX). The NYMEX futures contracts are based on the UX Consulting Company index. See [http://www.nymex.com/UX_pre_agree.aspx].

[91] EIA, at [http://www.eia.doe.gov/cneaf/nuclear/umar/summarytable1.html].

[92] Reported by the EIA as weighted-average price, short-, medium-, long-term, and spot market prices, for both U.S.-origin uranium and foreign-origin uranium. See [http://www.eia.doe.gov/cneaf/nuclear/umar/summarytable1.html].

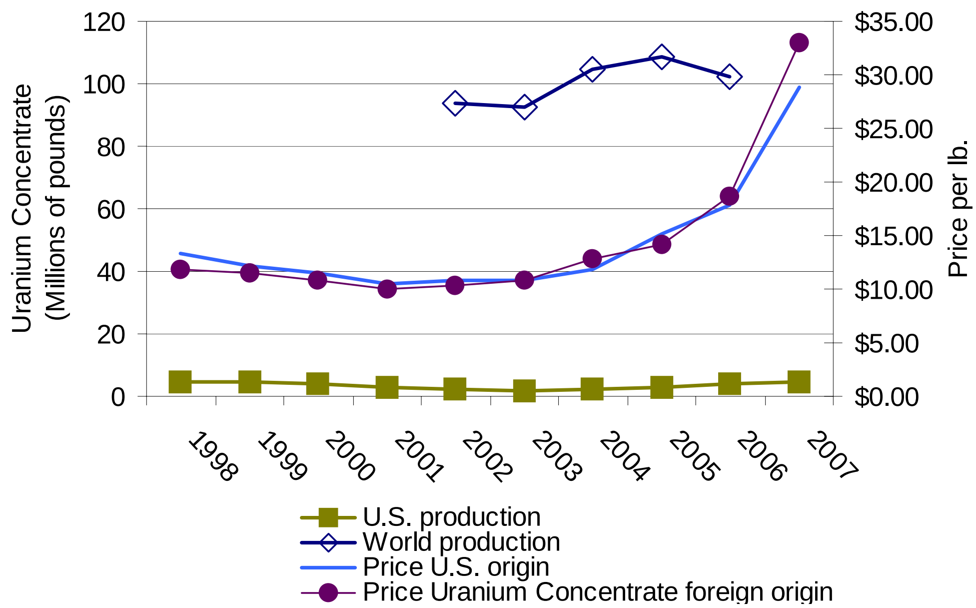
[93] UX Consulting Company, LLC, at [http://www.uxc.com/review/uxc_g_2yr-price.html].

[94] EIA, at [http://www.eia.doe.gov/cneaf/nuclear/dupr/dupr.html].

[95] *Ibid.*

uranium mining claims in Delores County, CO, from 396 in 2006 to 5,399 in 2007.[96] Mining claims do not necessarily mean new mining activity is taking place, but indicate an interest in developing the land for mining under the General Mining Law of 1872.[97]

Figure 12. Uranium Production and Price



Source: U.S. Dept. of Energy. Energy Information Administration. "Official Energy Statistics From the U.S. Government," at [http://www.eia.doe.gov/fuelnuclear.html].

Note: World production figures of U_3O_8 were unavailable prior to 2002. Also, U.S. production of U_3O_8 for 2002-2004 are estimates. Uranium price reflects the average annual weighted-average price, not the spot market price.

Some environmental groups have expressed concerns about the possibility of uranium contamination of soil and water from new uranium mining, especially near the Colorado River and Grand Canyon National Park.[98] This issue will be reviewed in the next section.

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[96] *Durango Herald* , "Uranium Speculation Skyrockets," (May 14, 2008).

[97] For more information, see CRS Report RL33908, *Mining on Federal Lands: Hardrock Minerals*, by Marc Humphries.

[98] Environmental Working Group Report, "Grand Canyon Threatened by Approval of Uranium Mining Activities" (January 2008), at [http://www.ewg.org/reports/grandcanyon] and [http://www.ewg.org/node/26743].

Issues For Congress[99]

Financial Market Policy Issues[100]

The 110th Congress has considered more than 36 bills to control the ability of speculators, and financial investors in general, from exerting undue influence on commodity market prices. Although this proposed legislation is primarily directed to oil market speculation, some of the provisions may apply to trading in metals as well. Both energy commodities and metals are "exempt commodities" under the Commodity Futures Modernization Act of 2000 (P.L. 106-554), and thus have been exempt from regulation by the Commodity Futures Trading Commission (CFTC). Specifically, trades that are on a principal-to-principal basis, not undertaken on a market-like trading facility, and trades carried out on an electronic trading facility, are exempt from CFTC oversight, creating the so-called "Enron Loophole."[101] Speculation and trading based on standardized contracts traded in a market like the New York Mercantile Exchange (NYMEX) are subject to CFTC regulation.

The Food, Conservation, and Energy Act of 2008 (P.L. 110-246, also known as the Farm Bill), extended CFTC regulation into electronic trading facilities if the CFTC finds that the contract traded had a significant role in price determination, that is, if the price is a reference point for other transactions or trading facilities. The provisions of the Farm Bill partially close the "Enron Loophole." Private transactions, not carried out on a trading facility in exempt commodities, including metals, are still not under CFTC oversight.

A number of bills in the 110th Congress seek to close what has been dubbed the "London Loophole." This results from different regulatory standards between nations; in this case the United States and the United Kingdom. The potential problem is that contracts, essentially identical to the NYMEX contracts, can be purchased in the United States, but traded on an exchange based in London, which potentially might allow investors to bypass CFTC technical trading requirements.

Another provision, the so-called "Swaps Loophole," has also been the focus of a number of bills in the 110th Congress. Institutional investors are likely to establish positions in commodity markets through the use of an intermediary, a commodity index fund, or a transaction with an investment bank. The dollar value of institutional investors' portfolios is large relative to the size of commodity markets. Through these investments, institutional investors can exceed the limits established by the CFTC on the number of contracts held. The net effect is that some investors, who are speculating on price movements, might hold positions in the market large enough to influence the price.

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[99] This section was written by Stephen Cooney, Robert Pirog,, and Marc Humphries.

[100] This section is based on CRS Report RL34555, *Speculation and Energy Prices: Legislative Responses,* Mark Jickling and Lynne J. Cunningham. More detail on each of the issues covered in this section, as well as summaries of each piece of proposed legislation, can be found in that report.

[101] Enron Corporation supported the idea of "exempt commodities."

Federal Minerals Policy Issues

In order to meet the congressionally stated minerals policy objectives, "...to promote an adequate and stable supply of materials necessary to maintain national security, economic well being, and industrial production ...,"[102] it may be useful to assess periodically industry vulnerability to supply disruptions. Congress could review, with industry, how the United States is positioned to effectively address potential supply disruptions or restrictions. Other areas that may be of interest to Congress include :

- An understanding of U.S. production potential and capacity based on reserve estimates, exploration expenditures, investment in downstream facilities, and labor and infrastructure requirements.

- The role of secondary recovery of materials, and whether federal research and development (R&D) investment could assist in the review and possible development of technologies and infrastructure for secondary supply sources.

- The role of substitute materials, including whether these materials exist, and at what point do they become economic. Also, is there a federal R&D role in the development of substitutes that could minimize risk of potential supply disruptions?

- Gaining a clearer picture of supply risk (where and how supply disruptions might occur and how they are addressed) by examining the supply cycle of materials produced domestically and elsewhere.

- Closer government monitoring of data for supply and demand of essential material requirements for the U.S. economy.

During the 110th Congress, attention has been focused on reforming the General Mining Law of 1872. One issue for Congress is access to public lands for mining uranium and other hardrock minerals, currently authorized under the 1872 Mining Law. The House passed broad-based legislation (H.R. 2262) to reform the 1872 Mining Law on November 1, 2007, and the Senate Committee on Energy and Natural Resources has held oversight hearings on hardrock mining on federal lands.

But Mining Law reform legislation would not likely have much impact on the domestic mining capacity or the import reliance of the essential minerals reviewed in this report. The vast majority of mining activity on federal lands is in gold mining. According to the last data published by the Interior Department,[103] gold accounted for 88% of the total dollar value of hardrock (base metals and nonmetals) minerals mined on federal lands. Although that report was written in the 1990s, it is unlikely that gold's dominance has decreased since then, because, while other metals prices

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[102] From 30 U.S.C. §1601, as quoted more fully above (see citation in fn. 57).

[103] U.S. Dept. of the Interior. Task Force on Mining Royalties. *Economic Implications of a Royalty System for Hardrock Minerals* (August 16, 1993).

have risen, so has the price of gold. The Interior report also showed that federal lands mineral production only represented about 6% of the value of all minerals produced in the United States. For example, federal lands contributed about 1% of the value of copper mined in the United States according to the report. Further, the report indicated that while all platinum group metal mines were initially located on federal lands, nearly all of those claims were later patented (transferred to private ownership).

Congress has also been interested in the environmental impact of mining on public lands. Uranium mining claims on federal lands have jumped from about 100 in 2003 to near 10,000 in 2007, according to the Department of the Interior. This has been controversial because several of these claims are located in what are described as environmentally sensitive areas (i.e., near the Grand Canyon). On June 19, 2008, Representative Raul Grijalva, Chair of the House Subcommittee on Natural Resources Subcommittee on National Parks, Forests, and Public Lands, introduced a resolution to withdraw public lands adjacent to the Grand Canyon National Park from uranium mining. On June 25, 2008, the House Natural Resources Committee adopted the resolution. Because a significant fraction of U.S. uranium resources is located on public lands in the West, reform of the 1872 Mining Law or other congressional action to limit or permit access for uranium exploration and mining could affect future U.S. uranium production. Legislation that has been introduced, the Grand Canyon Watersheds Protection Act of 2008 (H.R. 5583), would withdraw about one million acres around the Grand Canyon, and thus prohibit uranium mining in those withdrawn areas.

While the broad impact on the metals and ores covered in this report may be limited, Congress is continuing to examine the subject. Issues of the best use of public lands, fair returns to the public for access to publicly owned natural resources, and the environmental and economic consequences of the domestic mining industry are of interest.

Conclusion[104]

In general, the high prices of the mineral commodities reviewed in this report are a result of rapidly increasing global demand, increasing production costs, and tightening supplies. While production is expanding at the mine or refinery stage in most cases, it has generally not kept pace with rising demand. Higher metals mineral prices have led to expansions of some existing operations, reopening of historic projects (such as some iron ore mines, zinc mines in Tennessee and possibly the Climax moly mine in Colorado), and the development of new mining projects. High mineral prices have also resulted in significantly higher exploration expenditures. Annually, world exploration expenditures rose from around $2 billion in 2002 to over $10 billion in 2007.[105] The increase is spread across the precious metals and base

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[104] This section was prepared by Marc Humphries and Stephen Cooney.

[105] *Mining Engineering*, "Annual Mining Review" (May 2008).

metals spectrum. And, as shown above, high uranium prices have led to dramatic increases in the number of uranium claims staked on U.S. public lands.

This review of selected minerals and metals has shown that while mining and refining capital expansion projects may be in the works, any number of bottlenecks might arise among both domestic and foreign producers, such as electric power, skilled labor, and equipment shortages; labor unrest; weather or transportation delays; and, opposition on environmental policy grounds. Any of these could raise costs, exacerbate the tightness of supplies and, thus, raise prices.

Higher prices have led to more efficient use of materials in some cases. For example, there has been a reduction in the amount of platinum used in auto catalytic converters, or the substitution of the less expensive palladium for platinum when possible. As prices rise, another area of increased interest is secondary recovery of certain materials such as scrap iron and steel, copper, aluminum, and PGMs. There is a well established global infrastructure for secondary recovery for some materials but not for others, such as manganese. Although secondary recovery is beyond the scope of this report, it is worth noting that the amount of secondary material produced and imported into the United States has risen dramatically over the past five years. And so have exports of material, such as ferrous and nonferrous scrap, of which the United States is a major global supplier.

The United States is reliant on imports of many minerals that support its economy. For several minerals studied here, the United States is more than 90% import-reliant — e.g., manganese (100%), bauxite (100%), platinum (94%), and uranium (90%). For other minerals examined in this report, such as iron ore and molybdenum, the United States is self-sufficient. For refined aluminum, zinc and uranium, the United States' chief trading partner is Canada. While import reliance may be a cause for concern, high import reliance is not necessarily the best measure, or even a good measure, of supply risk. U.S. companies may be invested in overseas operations — e.g., copper and bauxite mines — and supply sources may be diversified, of higher quality, of lower cost, and located in countries that have extensive reserves and production capacity. Such conditions may not always exist in the United States, even when resources are present. Estimates of the global reserves of minerals reviewed in this report are substantial and appear to be sufficient to meet material needs in the foreseeable future.

However, as shown in the review of market conditions and policies, including rising foreign demand, prices may still be more volatile in the short term At best, from the viewpoint of U.S. metals consuming industries, increased production and supply of ores and metals may bring relative price stability over the longer term. But despite increased production, fundamental market changes could reverse the historic long-term downward price trend of the twentieth century, and U.S. industry could be in for a long period of rising metals prices.