Cr, Cu, Mn, Mo, Ni, and Steel Commodity Price Influences, Version 1.1

By John F. Papp, Lisa A. Corathers, Daniel L. Edelstein, Michael D. Fenton, Peter H. Kuck, and Michael J. Magyar

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

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Summary

This report contains the 55 slide images from a presentation made by the author at the meeting of the Metal Powder Industries Federation held in Denver, CO, on May 15, 2007.

The Metal Powder Industries Federation (MPIF) invited the U.S. Geological Survey (USGS) to speak at their annual meeting about the factors that influence prices for chromium, copper, manganese, molybdenum, nickel, and steel. These metals are of interest to MPIF because the prices of these raw materials used by their industry were at historically high levels. Because the USGS closely monitors, yet neither buys nor sells, metal commodities, it is an unbiased source of metal price information and analysis.

The authors used information about these and other metals collected and published by the USGS (U.S. production, trade, stocks, and prices) and about consumption and stocks internationally by country from industry organizations that publish such information, because metal markets are influenced by activities and events over the entire globe.

By seeking a common cause for common behavior among the various metal commodities, the authors found that major factors that influence prices of metal commodities were major international events such as wars and recessions, and major national events such as the dissolution of the Soviet Union in 1991 and economic growth in China, which started with the open door policy in the 1970s but did not have significant market impact until starting in the 1990s. Metal commodity prices also responded to commodity-specific events such as tariff or usage changes or mine strikes.

Slide 1

The title of this presentation is “Chromium (Cr), copper (Cu), manganese (Mn), molybdenum (Mo), nickel (Ni), and steel commodity price influences.” The authors are John F. Papp, Lisa A. Corathers, Daniel L. Edelstein, Michael D. Fenton, Peter H. Kuck, and Michael J. Magyar of the U.S. Geological Survey. These slides were presented at the Metal Powder Industries Federation meeting on May 15, 2007 in Denver, CO.

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By John F. Papp, Lisa A. Corathers, Daniel L. Edelstein,
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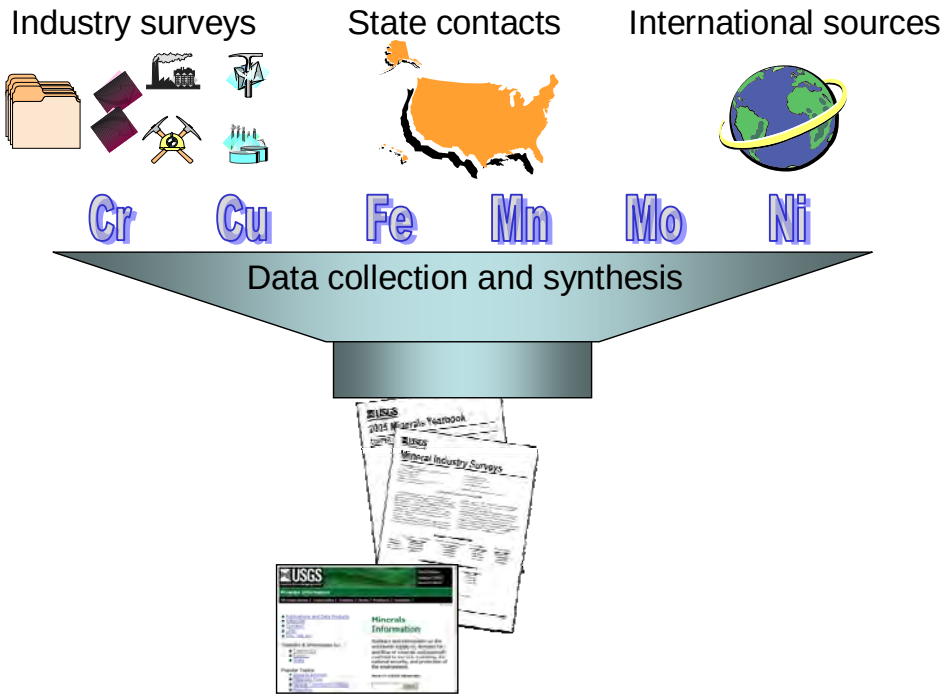
U.S. Geological Survey

Presented at
Metal Powder Industries Federation meeting
May 15, 2007
Denver, CO

Slide 2

The USGS collects minerals information domestically from producers and consumers and internationally from a variety of sources in foreign countries.

U.S. Geological Survey
Minerals Information Team



http://minerals.usgs.gov/minerals/

Slide 3

Prices and factors that influence prices such as production, consumption, stocks, trade, and issues are among the information collected and reported by the USGS via the internet. USGS uses the information to quantify national apparent consumption, price trends, materials flow, and import reliance. (Net import reliance is imports minus exports plus adjustments for stock changes. Apparent consumption is principal (i.e., from mining) plus secondary (i.e., from recycling) production plus net import reliance.)

This word slide states: Information collected comprises production, consumption, stocks, trade, prices, and issues. Analysis comprises apparent consumption, import reliance, price trends, and material flow studies.

Information collected

Production
Consumption
Stocks
Trade
Prices
Issues

Analysis

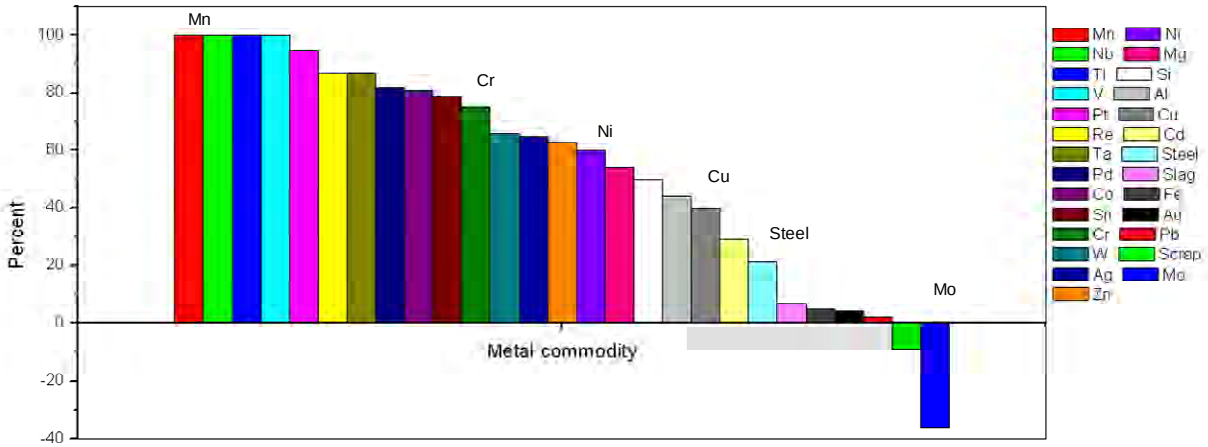
Apparent consumption
Import reliance
Price trends
Material flow studies

Slide 4

For example, U.S. net import reliance as a percent of apparent consumption, reported annually for metal commodities in the Mineral Commodity Summaries, ranges from a high of 100% for manganese, niobium, thallium, and vanadium to a low of negative 36% for molybdenum, a material for which the United States is a net exporter. The labeled bars are those of 6 representative metals; Cr, Cu, Mn, Mo, Ni, and steel.

This chart shows bars for 27 metal commodities proportional to the metals' net import reliance expressed as a percentage of apparent consumption in descending order.

Metal commodity net import reliance as a percent of apparent consumption



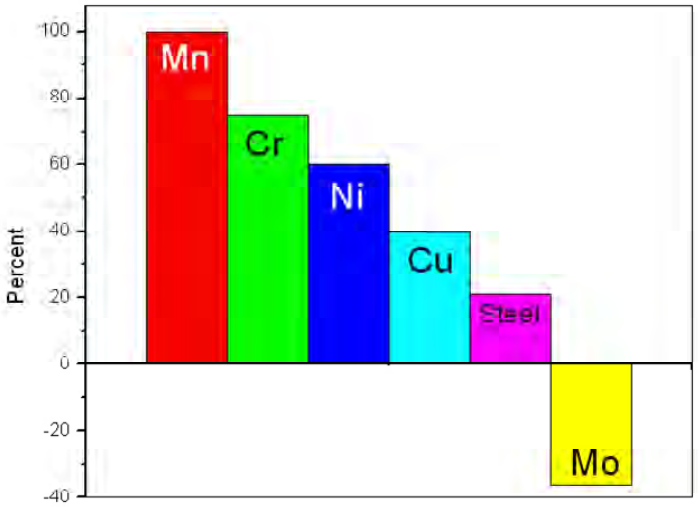
Source: Mineral Commodity Summaries 2007

Slide 5

Net import reliance as a percent of apparent consumption for the representative metals only.

This chart shows bars for 6 representative metal commodities proportional to the metals' net import reliance expressed as a percentage of apparent consumption in descending order.

Cr, Cu, Mn, Mo, Ni, steel net import reliance as a percent of apparent consumption



Source: Mineral Commodity Summaries 2007

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Slide 6

The long-time-period prices (1900-2004) are unit values of apparent consumption, so for some of these metals they represent a composite of forms. The short-time-period prices (1991-2006) are those reported in the Mineral Commodity Summaries publication series. (Sources: Historical Statistics of Minerals and Materials in the United States, Data Series 140. Mineral Commodity Summaries, various years.)

This word slide states: “Cr, Cu, Mn, Mo, Ni, and steel commodity prices (1900-2004).”

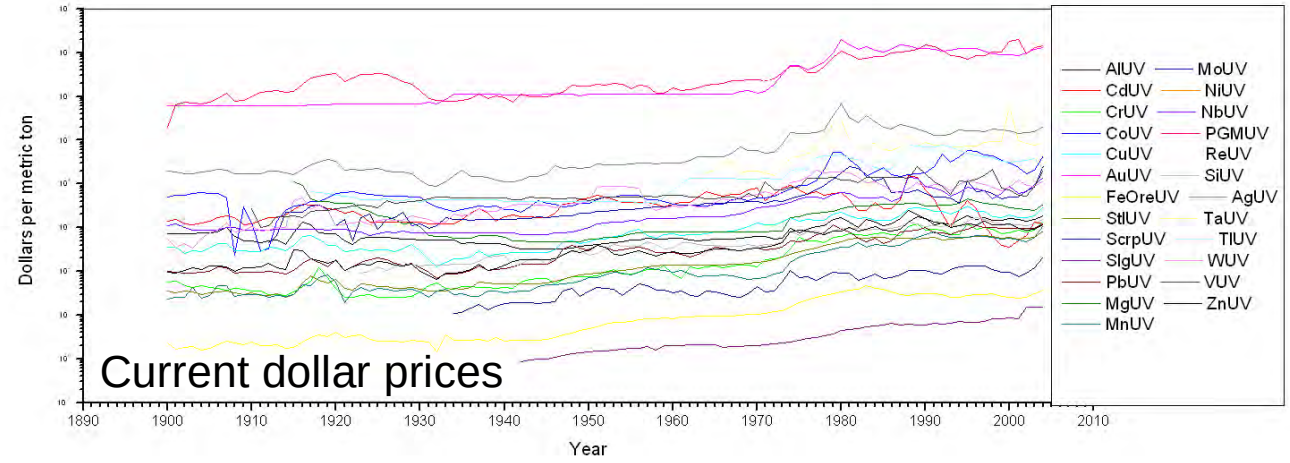
Cr, Cu, Mn, Mo, Ni, and steel commodity prices (1900-2004)

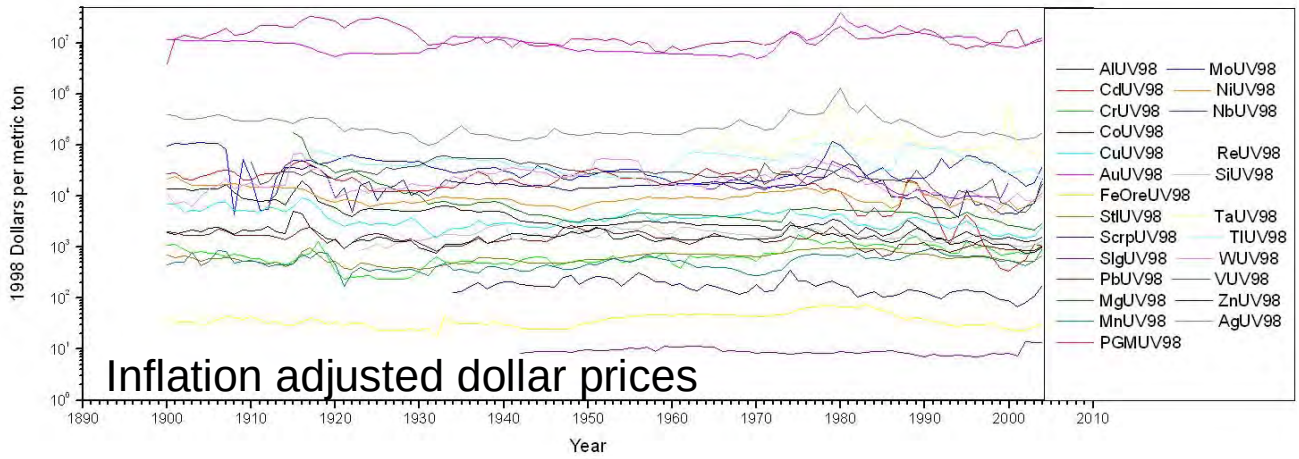
Slide 7

These price histories create a jumbled mess of lines that are a headache to untangle and present in a visually appealing way, not to mention that these prices range widely. They are shown together here on a logarithmic graph to accommodate the wide range of values on a compact scale.

Comparing prices plotted in current dollars with those plotted in inflation adjusted dollars, it is apparent that the generally upward price trend in current dollars disappears in inflation adjusted dollars. (Sources: Historical Statistics of Minerals and Materials in the United States, Data Series 140.)

These two line graphs show the prices of 25 metal commodities from 1900 through 2004 on a logarithmic scale in current dollars in the upper graph and in inflation adjusted dollars in the lower graph.


Dollars per metric ton
Year
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
AlUV
MoUV
CdUV
NiUV
CrUV
NbUV
CoUV
PGMUV
CuUV
ReUV
AuUV
SiUV
FeOreUV
AgUV
StlUV
TaUV
ScrpUV
TlUV
SlgUV
WUV
PbUV
VUV
MgUV
ZnUV
MnUV
Current dollar prices


1998 Dollars per metric ton
Year
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
AlUV98
MoUV98
CdUV98
NiUV98
CrUV98
NbUV98
CoUV98
CuUV98
ReUV98
AuUV98
SiUV98
FeOreUV98
StlUV98
TaUV98
ScrpUV98
TlUV98
SlgUV98
WUV98
PbUV98
VUV98
MgUV98
ZnUV98
MnUV98
AgUV98
PGMUV98
Inflation adjusted dollar prices

Slide 8

Here are the same price histories for the 6 representative metals shown on a logarithmic scale and in three panels on a linear scale in current dollars.

Common behavior shown is:

(1) Prices start out low and end up high.

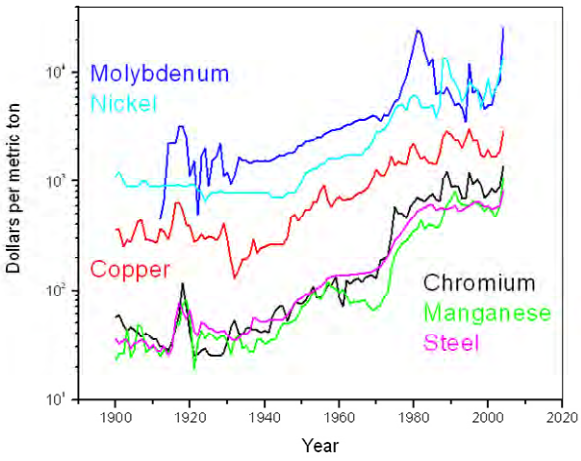
(2) Price fluctuations are smaller in the middle of the time period (about 1940-1960) than they are at the beginning or end.

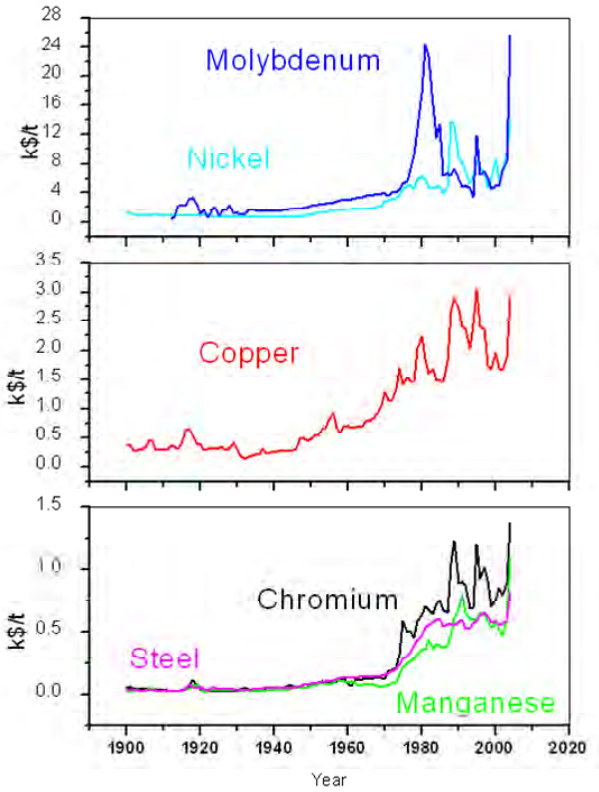
(3) Prices were at historically high levels at the end of time period for most of these metals.

The quantitatively larger price changes apparent in the recent years are no larger, as a percent of current price, than price changes in the early part of the time period.

It appears that there was greater price stability in the middle of the time period as implied by the smaller price fluctuations there.

Prices





Units: $/t - Current U.S. dollars per metric ton.

Slide 9

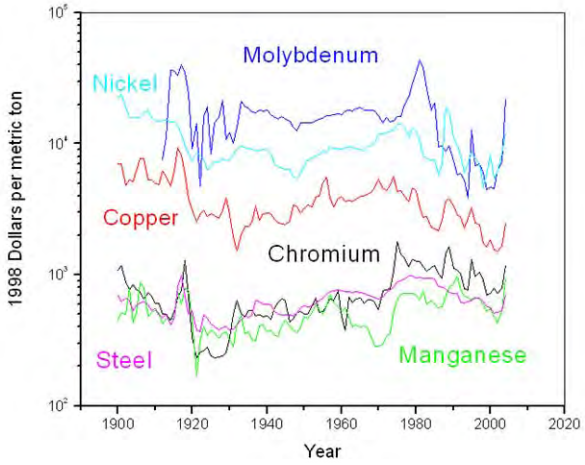
The 6 representative metals (shown here in inflation adjusted dollars) show more clearly that:

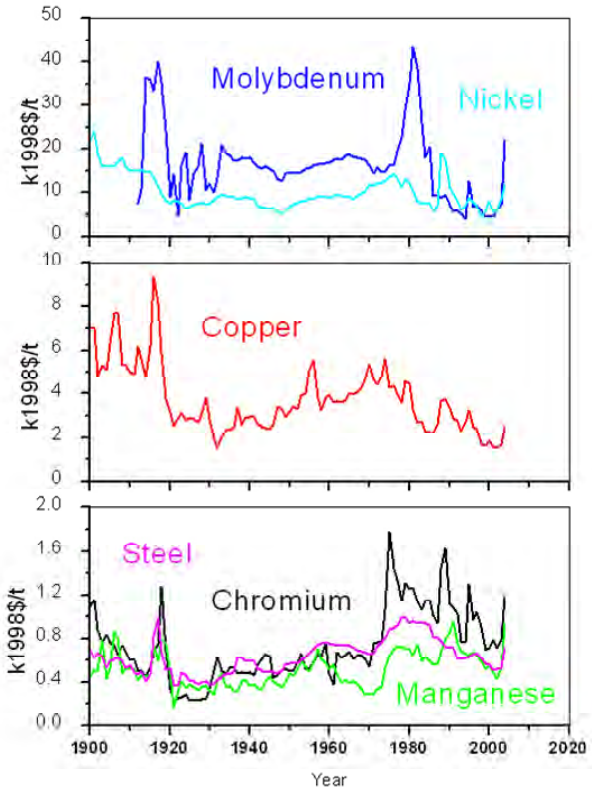
(1) Measured in current dollars, prices have risen; however, measured in inflation-adjusted dollars, prices in 2004 are quite similar to their historical values, marginally higher, or even less.

(2) Measured in current dollars, price fluctuations are greater than they used to be; however, measured in inflation-adjusted dollars, price fluctuations are quite similar to historical fluctuations.

There is a pattern of fluctuating prices throughout the time period; however, there was relative price stability in the central portion of the time period (about 1940-1960) owing to government price controls and allocations during wartime.

Prices





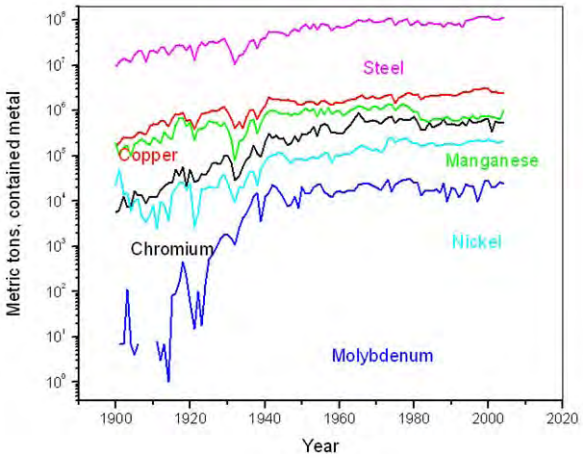
Units: 1998$/t - Price deflated to 1998 dollars per metric ton.

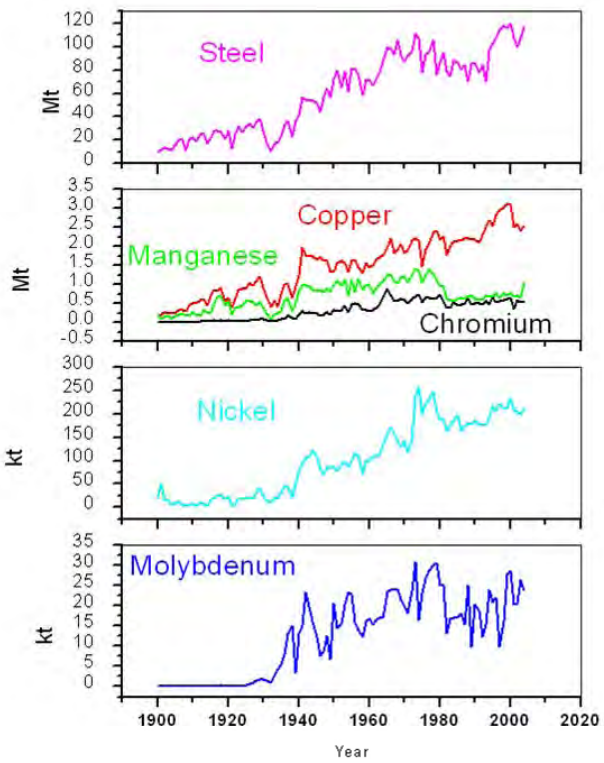
Slide 10

Demand influences price. The four panels show U.S. apparent consumption (1900-2004) of these metals. The same data are plotted together on a logarithmic graph to accommodate the wide range of values on a compact scale.

Notice that the trends appear similar. They start low and end up high. In 2004, there was a high level of consumption on an ascending curve.

U.S. apparent consumption (AC)



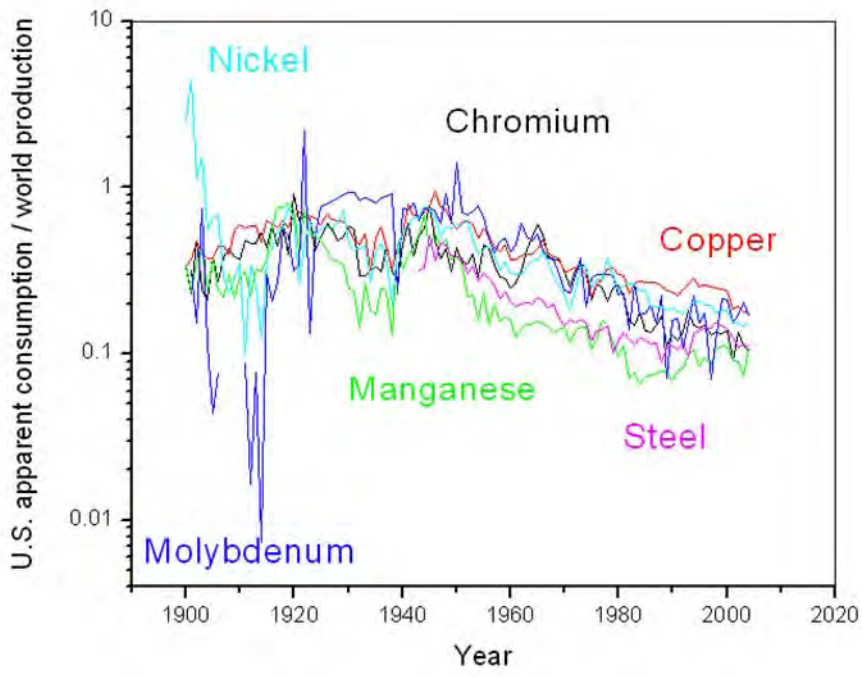


Slide 11

U.S. mineral commodity apparent consumption divided by world mine production (AC/WP), a measure of U.S. consumer importance, for the 6 representative metals shows that during and shortly after WWII to about 1950, the United States consumed a significant fraction of world production. It was said that “when the United States sneezes, the world catches a cold,” because of the large impact U.S. consumption had on the world economy when the United States was the leading consumer of these metals.

From 2001-2004 the United States accounted for less than 20% of the consumption of any of these metals; much less than it once did. Only for Mo is the United States the leading world producer. For the remaining metals, the United States is not **the** leading producer, and for none of them is the United States **the** leading consumer.

U.S. apparent consumption divided by world production



Slide 12

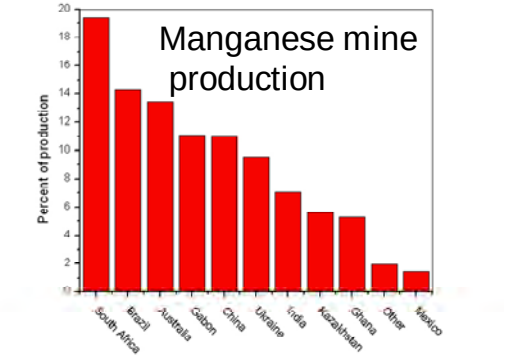
The geographic distribution of metal mining is dependent upon the location of economic deposits. Consumption of these metals is now distributed among several leading consumers and many smaller consumers that are geographically distributed about the globe; in other words, consumption is globalized. The bar charts show percent of 2001-2005 average production or consumption by country in descending order.

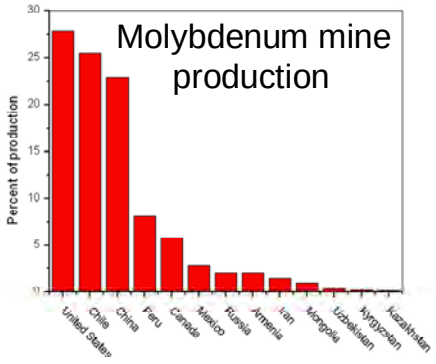
Among more than 10 manganese-producing countries, the leading producer (South Africa) accounts for about 20% of production; the next two (Brazil and Australia), about 15% each. Among 13 molybdenum-producing countries, the 3 leading producers (United States, Chile, and China) account for about 25% each. Among 22 chromite ore-producing countries, the leading producer (South Africa) accounts for over 40% of production; the next two (Kazakhstan and India), under 20% each. The leading chromium consumers (Japan, China, United States, and Germany) account for about 5% to 10% each.

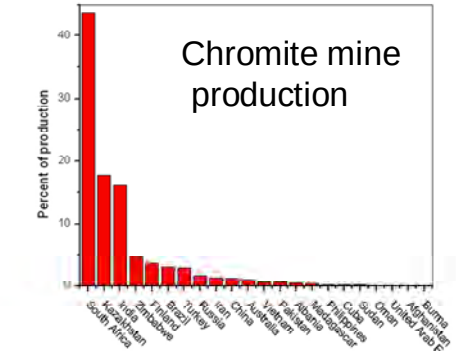
When one country accounts for a large share of production or consumption, it suggests that that country could have a large impact on the commodity price. An extreme example might be, if mine production from South Africa were disrupted, to compensate for that loss the remaining producers would have to increase their production by a factor of 1.75 for chromium and 1.25 for manganese.

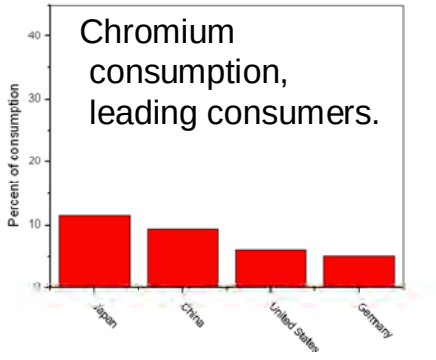
Manganese and molybdenum have the fewest number of mine-producing countries.

Geographic distribution of world mine production and metal consumption





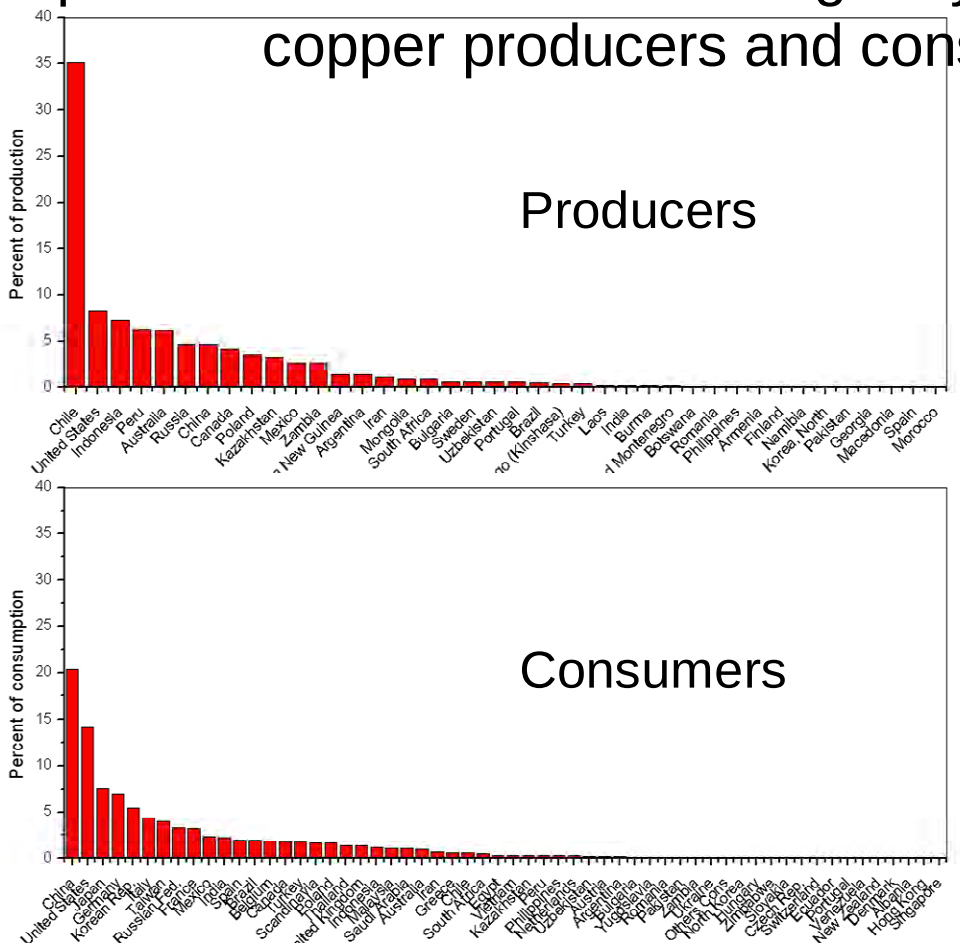




Slide 13

Based on 2001-2005 average production, among the nearly 50 copper-producing countries, the leading producer (Chile) accounted for 35% of production while the next two (United States and Indonesia) accounted for 8% and 7%, respectively. Based on 2002-2006 average consumption, among the nearly 60 copper-consuming countries, the leading copper consumer (China) accounted for 20%, the second leading consumer (United States), 15%; and the remaining consumers accounted for less than 7% each.

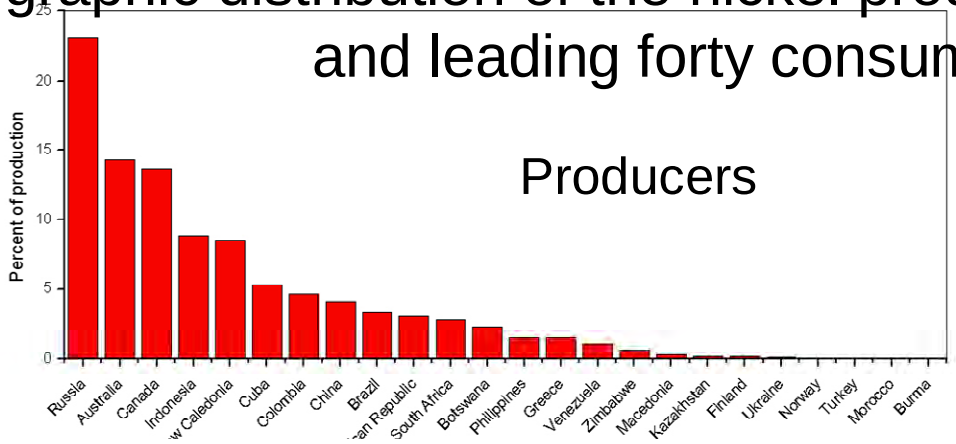
Geographic distribution of the leading forty copper producers and consumers

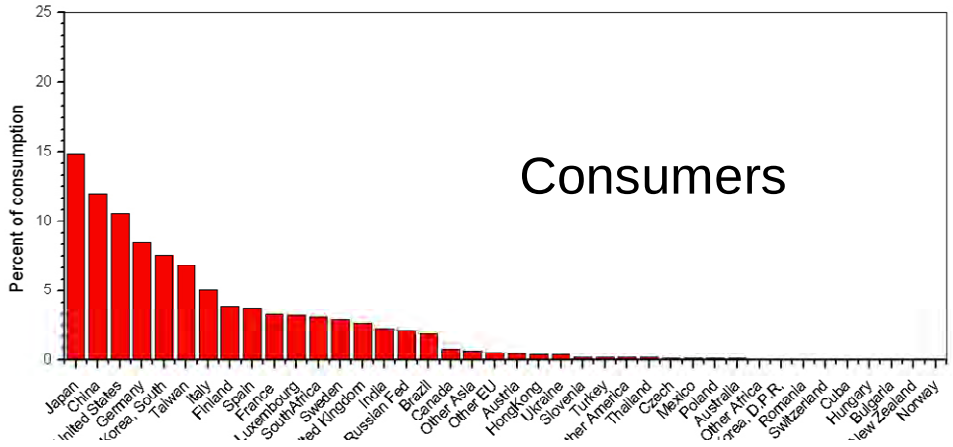


Slide 14

Based on 2001-2005 average production, among the more than 20 nickel-producing countries, the leading producer (Russia) accounts for over 20% of production; the next two (Australia and Canada), about 15% each. Based on 2002-2006 average consumption, among the nearly 50 nickel-consuming countries, the leading consumer (Japan) accounts for 15%, while the next two (China, and United States) account for 12% and 11%, respectively.

Geographic distribution of the nickel producers and leading forty consumers

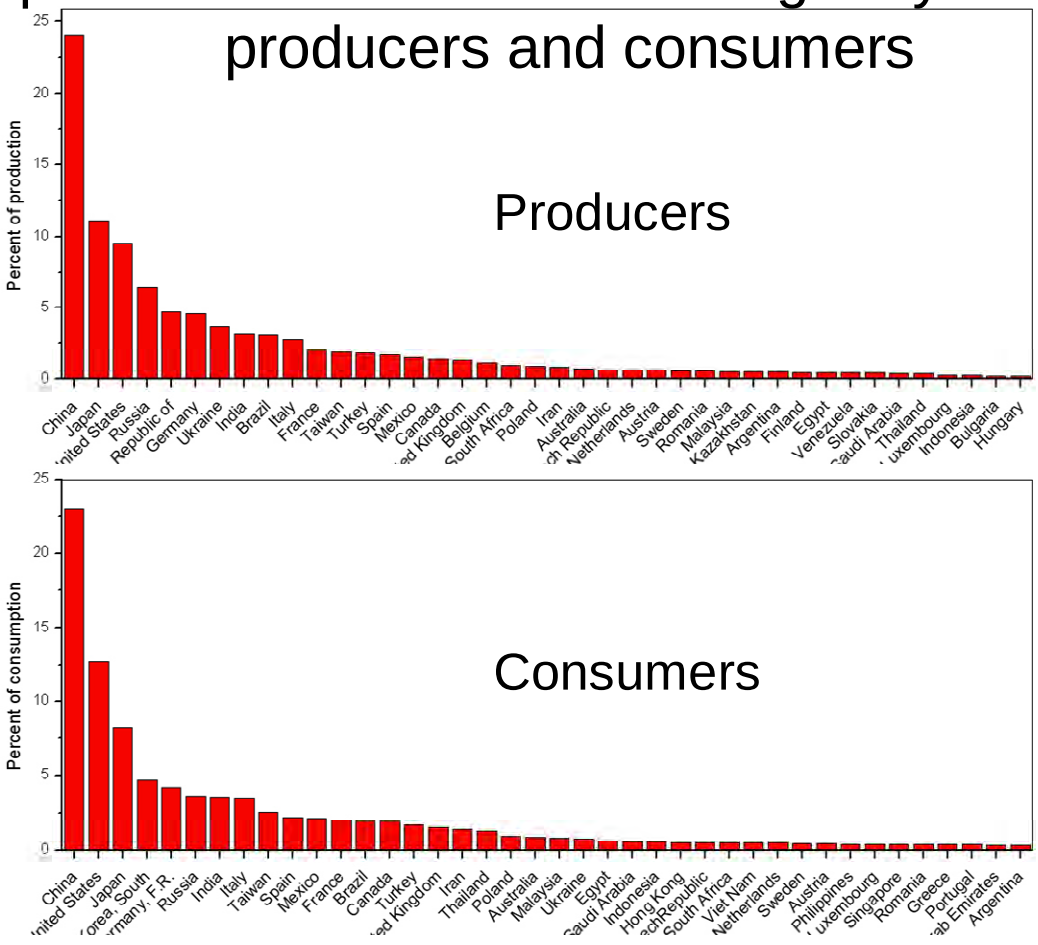




Slide 15

Based on 2001-2005 average production, of the more than 90 steel-producing countries, the leading producer (China) accounted for about 25%; remaining producers accounted for about 10% or less, each. Based on 2000-2004 average consumption, among steel-consuming countries, the leading consumer (China) accounted for 23%; the second leading consumer (United States), 13%; and the remaining consumers, less than 9% each.

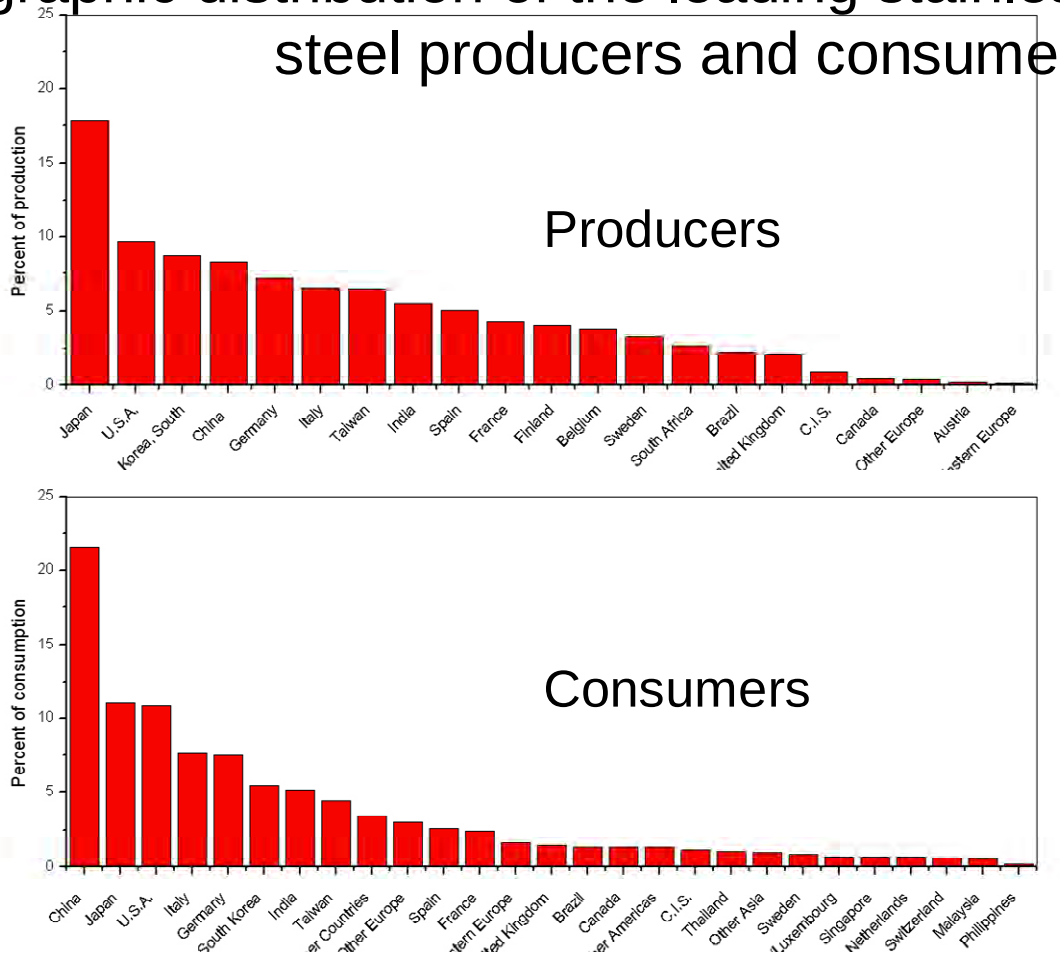
Geographic distribution of the leading forty steel producers and consumers



Slide 16

Based on 2001-2005 average production, of the more than 20 stainless steel-producing countries, the leading producer (Japan) accounted for less than 20% and the remaining producers accounted for less than 10% each. Based on 2001-2005 average consumption, among stainless steel-consuming countries, the leading consumer (China) accounted for 22%; the second and third leading consumers (Japan, United States), 11% each; and the remaining consumers, less that 8% each.

Geographic distribution of the leading stainless steel producers and consumers



Slide 17

Commodity characteristics of chromium, copper, manganese, molybdenum, nickel, and steel.

This word slide states: Commodity characteristics for Chromium, Copper, Manganese, Molybdenum, Nickel, and Steel.

Commodity characteristics

Chromium
Copper
Manganese
Molybdenum
Nickel
Steel

Slide 18

Generally, metal ores are mined, beneficiated, and then processed to extract metal. Mining factors affect the production cost, and therefore, the price of metals. Some considerations are whether the metal is mined as principal product or as byproduct (or both). If it is a principal product, production can more easily respond to price changes. Byproduct metal production depends on the principal products' market conditions. For example, molybdenum is produced in significant amounts as both a principal product and as a byproduct of copper production.

Copper and molybdenum are produced domestically; chromium, manganese, and nickel are not.

Recycling markets contribute a significant amount to the production of Cr, Cu, Ni, and steel. Industry has integrated these recycled materials into process streams to the degree that they are now essential feed materials and commodities. There are large, active markets for used copper, chromium, nickel, and steel for recycling.

This word slide states.

Metal mining and processing characteristics

Mining:	
Principal Product	Cr, Cu, Mn, Mo, Ni, Fe (steel)
Byproduct/coproduct	Mo
U.S. mine production	Cu, Mo, Fe (steel)
Ore type:	
Sulfide	Cu, Mo, Ni
Oxide	Cr, Mn, Fe (steel)
various	Ni
Recycling:	Cr, Cu, Ni, steel

Metal mining and processing characteristics

Mining:	
Principal Product	Cr, Cu, Mn, Mo, Ni, Fe (steel)
Byproduct/coproduct	Mo
U.S. mine production	Cu, Mo, Fe (steel)
Ore type:	
Sulfide	Cu, Mo, Ni
Oxide	Cr, Mn, Fe (steel)
various	Ni
Recycling:	Cr, Cu, Ni, steel

Slide 19

Cu, Ni, and Fe (steel) are base metals; Cu and Ni are a precious-like metal in the sense that they are purchased by investors as are gold, silver, and platinum group metals; Cu and Ni are nonferrous metals; Cr, Mo, and Ni are alloying elements; and Mn is a deoxidizer.

Cr, Mo, and Ni are used in significant amounts as alloying elements in stainless steel. Mn, Mo, and Fe are used in the production of steel.

Cr, Cu, Ni, and steel have significant recycling production and scrap metal markets.

This word slide states:

Dominant metal uses

Base metal	Cu, Ni, steel
Precious-like metal	Cu, Ni
Nonferrous metals	Cu, Ni
Ferrous metals	Cr, Mn, Mo, Ni, steel
Alloying metal	Cr, Mo, Ni
Deoxidizer	Mn
Steel (all grades)	Mn, Mo, steel
Stainless steel	Cr, Mo, Ni
Reused/Recycled	Cr, Cu, Ni, steel

Dominant metal uses

Base metal	Cu, Ni, steel
Precious-like metal	Cu, Ni
Nonferrous metals	Cu, Ni
Ferrous metals	Cr, Mn, Mo, Ni, steel
Alloying metal	Cr, Mo, Ni
Deoxidizer	Mn
Steel (all grades)	Mn, Mo, steel
Stainless steel	Cr, Mo, Ni
Reused/Recycled	Cr, Cu, Ni, steel

Slide 20

Numerous factors affect commodity prices. Economists tell us that high prices result from scarcity. Business analysts tell us that supply-demand balance determines price. Investment analysts tell us that expectations play an important role in determining price. Commodity analysts tell us that price increases as the number of weeks of supply in stocks diminishes. Financial market analysts tell us that increased speculative investment in metals causes the price to rise.

This word slide states.

Factors Affecting Price

- Scarcity.
- Supply/demand balance.
- Stocks/rate of use.
- Actual or anticipated supply disruption.
- Earnings, market performance, expectations.
- Investment level.

Factors Affecting Price

- Scarcity.
- Supply/demand balance.
- Stocks/rate of use.
- Actual or anticipated supply disruption.
- Earnings, market performance, expectations.
- Investment level.

Slide 21

Globalization is important because many countries now play a role in metal production and consumption. Events in any of those countries may affect metal price.

Governments set trade policy (taxes, penalties, and quotas) that affect supply by restricting material flow. They set the rules for resource extraction. They are the source of demand when they build stockpiles and the source of supply when they dispose of them.

Geopolitical events involving governments or economic paradigms and armed conflict can cause major changes. Historically, we've had two world wars and restructuring of national economies. There is no reason to believe that such events will no longer happen. That these events have happened is reason to ask, what will happen where next, and which metals will be affected.

Businesses grow and reorganize. Despite the best business planning, demand can get ahead of supply when new production facilities come on stream late or do not perform as expected. Supply can get ahead of demand when a capacity increase exceeds industry's ability to absorb the potential new production.

There is also a national economic growth factor. Societies, as they develop, demand metals in a way that depends on their current economic position. For example, development in a country that does not have road, rail, and building infrastructure would make a greater demand on metals use than would the development of a country that has abundant amounts of transportation, housing, and basic services.

This word slide states.

Other Factors

- Globalization
- Government
- Geopolitics
- Growth
- Exchange rate (value of the dollar)
- Cost of production (energy, taxes, labor, etc)

Other Factors

- Globalization
- Government
- Geopolitics
- Growth
- Exchange rate (value of the dollar)
- Cost of production (energy, taxes, labor, etc)

Slide 22

Events and trends such as world wars, national economic growth, the Asian Financial Crisis (1997-98), and recessions have affected metal prices. Technologic developments that affect production, such as froth flotation, and technologic developments that affect demand, such as the growth of power and communication industries that required copper wire or the subsequent transition to fiber optic communication and, most recently, to wireless communication have affected metal prices.

Commodity-specific events (such as the construction of new production facilities or processes, new uses, unexpected mine or plant closures, or industry restructuring) affect metal prices.

Price factors

Economic trends

Technologic developments

Commodity specific events

Random variation

Slide 23

This word slide states: The individual metals, steel, copper, chromium, manganese, molybdenum, and nickel (1991-2006).

The individual metals: Steel, Cu, Cr, Mn, & Ni (1991-2006)

Slide 24

Steel is produced and consumed in far greater quantities than any of the other metals. The United States is a major steel producing and consuming country. Steel scrap is the second leading produced and consumed metal.

This word slide states: Steel (1901—2006)

Steel
(1991-2006)

Slide 25

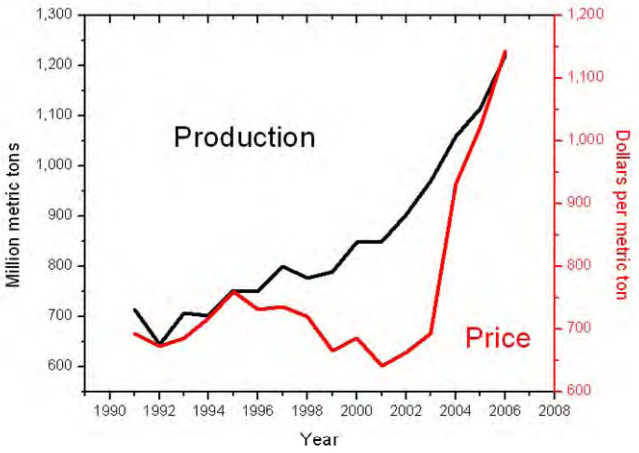
Steel comprises alloy steel, carbon steel, and stainless steel, which are sometimes collectively called “steel, all grades.” In this presentation, “steel, all grades” is referred to as “steel” and stainless steel is referred to by name.

From a peak in 1995, steel price declined until 2001 when it started to increase. Steel production rose steadily after a low in 1992.

It was during the “falling price” time period that the U.S. steel industry moved from open hearth steelmaking to electric furnace steelmaking and from billet casting to continuous casting, technological changes that contributed to lower production cost. We can see that percent change in steel price and world steel production are similar.

(The steel price used here was reported as a price index in the Iron and Steel chapter of the Mineral Commodity Summaries (which is the Producer Price Index for Steel Mill Products reported by the Department of Labor, Bureau of Labor Statistics) and converted to a price based on unit value of 1982 U.S. trade of steel mill products as reported in the Iron and Steel chapter of the Minerals Yearbook.)

Steel production and price



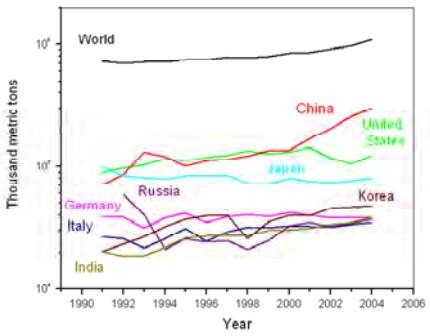
World steel production and price.

World steel production and price percent change.

Slide 26

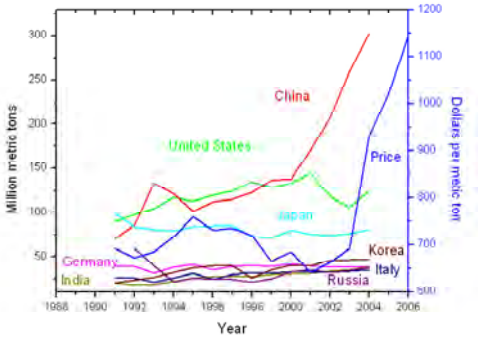
Leading national steel consumers sort into two groups; countries (China, Japan, and the United States) that consume over 70 Mt/yr and countries (Germany, India, Italy, Russia, and Korea) that consume between 30 Mt/yr and 70 Mt/yr. Since 1991, world steel consumption has been growing at 3.5% per year while that of the United States and Japan has been growing at 2.5% per year and 1.5% per year, respectively. China's has been growing at 12% per year. Among 70-Mt/yr consumers, China moved from the least amount of consumption to greatest amount during this time period.

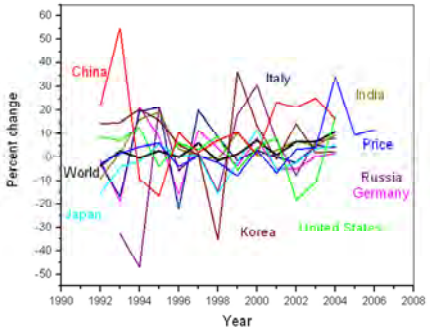
Steel consumption



World and national steel consumption.

Steel consumption by leading consumers and price.



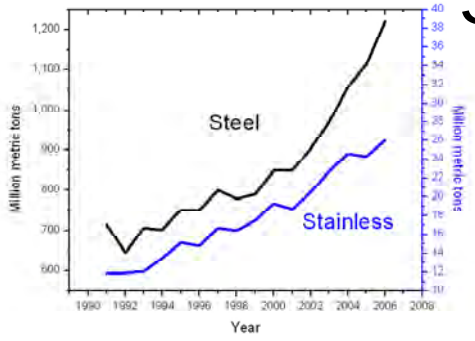


World and national steel consumption and price percent change.

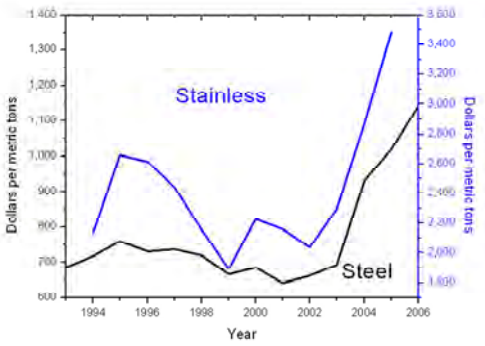
Slide 27

Some metals are associated more with steel (manganese and molybdenum), some more with stainless steel (chromium and nickel). As a part of the steel industry, stainless steel is influenced by many of the same factors that influence steel; however, as a major part of the steel industry that serves specialized markets, stainless steel trends may differ from those of the steel industry. For example, over the (1992-2006) time period, average annual growth for world steel production has been about 3.5% while that of stainless steel production has been over 5%. Stainless steel price is sensitive to the cost of chromium and (mostly) nickel while that of steel (other than stainless, mostly) is not. (The "price" for stainless steel is the average U.S. trade unit value averaged over all mill products.)

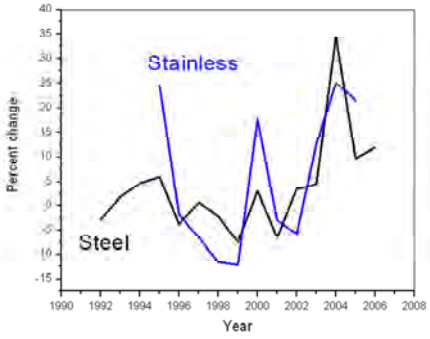
Steel and Stainless Steel



World steel and stainless steel production.



World steel and stainless steel price.

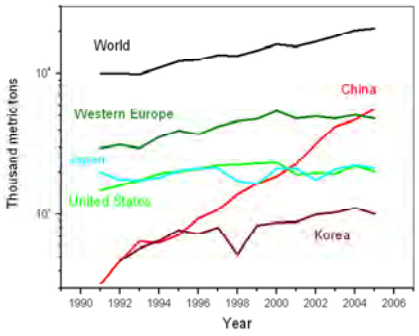


World steel and stainless steel price percent change.

Slide 28

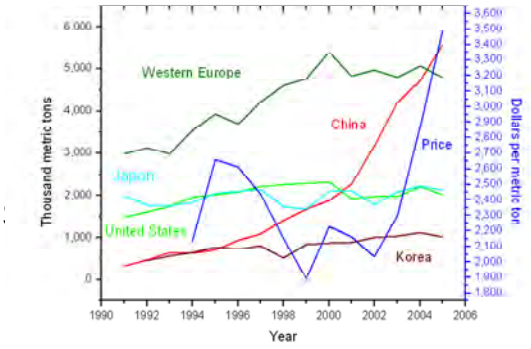
World and national stainless steel consumption, shown together here on a logarithmic graph to accommodate the wide range of values on a compact scale, show that stainless steel consumption is growing (5%/yr) as is that of the leading consumers; however, China is growing the fastest (22%/yr) and has taken a leading role as a stainless steel producer and consumer. Compared with Japan, Korea, United States, and Western Europe, China moved from the least amount of consumption to the greatest amount during this time period. (The price of stainless steel used here is mass-weighted average of U.S. stainless steel mill product trade.)

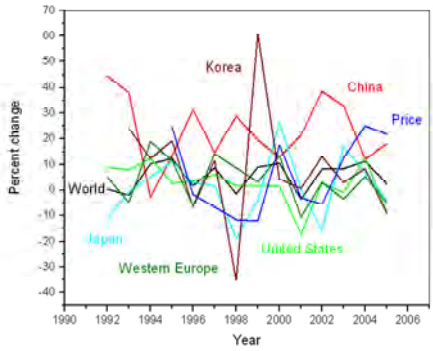
Stainless steel consumption



World and national consumption of stainless steel.

Stainless steel consumption by leading consumers and price.





Stainless steel consumption by leading consumers and price percent change.

Slide 29

Copper is produced from an oxide or sulfide ore after which it is converted to copper metal. The United States produces a significant amount of copper and is a leading copper consumer.

This word slide states: Copper Cu (1991-2006).

Copper
Cu
(1991-2006)

Slide 30

From a peak in 1995, copper price declined until 2003 when it started to increase. Copper mine production rose over the 1995-2003 time period. 2003 is the year that copper stocks started to decline.

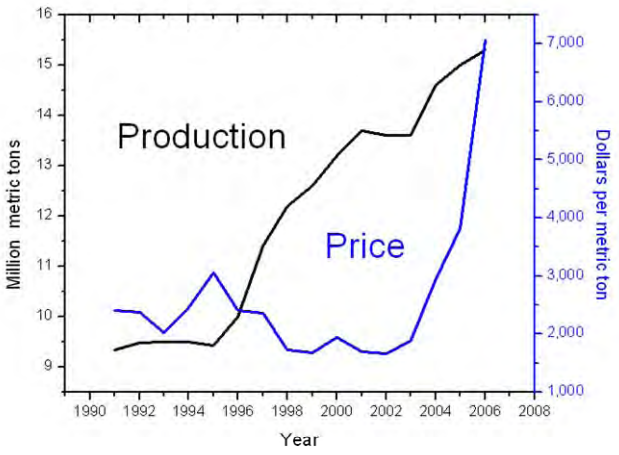
Stocks are the buffer between production and consumption. They are the reservoir of material that permits production and consumption to balance. Stock changes indicate the imbalance between production and consumption.

Like that of the other metals, world copper mine production was increasing while copper price was declining or steady. The stocks-price graph shows that demand got ahead of supply in 2003 when stocks dropped to near historic low levels and price rose. Stocks continued to decrease until 2005.

The price drop in 1997 followed the discovery in 1996 that a rogue trader used trading company money to maintain the price of copper. Copper is traded internationally and production, consumption, and stock information are widely available. The copper market is relatively transparent. The balance between production and consumption affects price; stocks changes indicate the degree and direction of balance in the market. Demand is reduced by recessions; supply can be delayed by long lead times for new facilities.

The strong relation between stock and price levels and changes suggests that an analysis of the effect of an event on prices is incomplete without knowledge of stocks.

Copper production



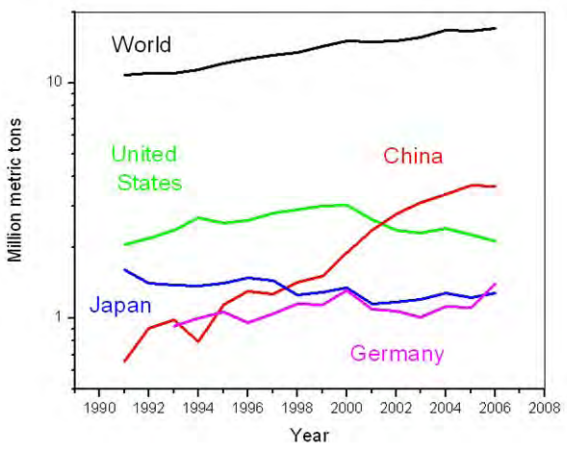
World copper mine production and price.

Copper (LME) stocks and price.

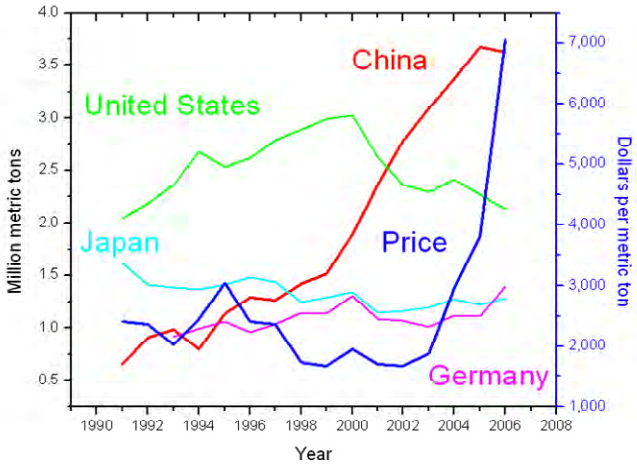
Slide 31

The leading copper-consuming countries (China, Japan, Germany, and the United States) consumed a similar amount of consumption annually, shown together here on a logarithmic graph to accommodate the wide range of values on a compact scale; however, notice that China moved from the least amount of consumption to the greatest amount during this time period. Of the leading consuming nations, China's (most significantly) and Germany's consumption increased over the 1991-2006 time period as did copper price starting in 2003, the year that copper stocks started to drop.

Copper consumption



World and national copper consumption.



Copper consumption by leading consumers and price.

Slide 32

Chromium is mined as an oxide ore and must be smelted in an electric arc furnace (to make ferrochromium) before it can be used by the steel industry. It is used primarily as an alloying element in stainless steel.

This word slide states: Chromium Cr (1991-2006)

Chromium
Cr
(1991-2006)

Slide 33

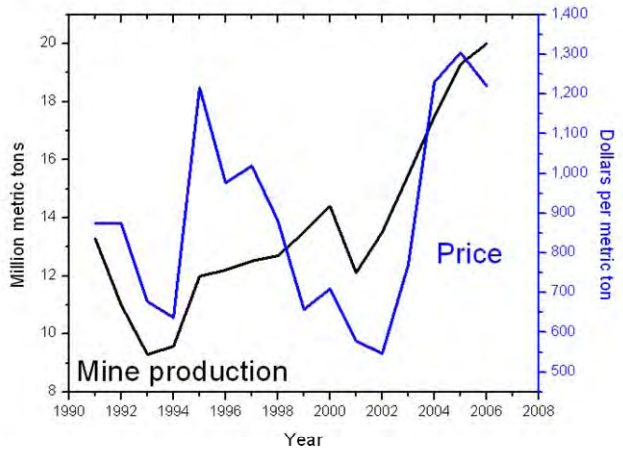
The chromium industry's production capacity expansion to meet sustained stainless steel demand was delayed by antiapartheid policies and dissolution of the Soviet Union, an event that reduced demand, and put chromium-containing materials on the market until 1994 as stocks in the former Soviet Union were sold off. It took until 1995 for world demand to catch up with installed capacity as indicated by the price increase in that year.

In 2003, the price of chromium rose 40% following two consecutive years of strengthening of the South African rand, which rose 24% against the U.S. dollar in 2003 alone.

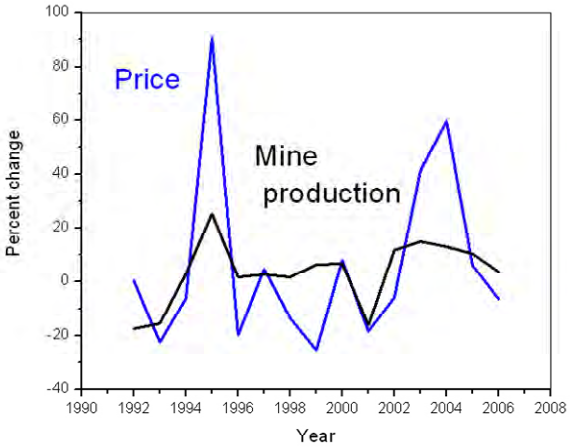
The rising cost of ferrochromium production and a strengthening South African rand, along with increased demand for ferrochromium and limited supply of stainless steel scrap, caused the price of ferrochromium to reach historically high levels in 2004. Carbon for electrodes was in short supply as were electrical power and transportation in South Africa.

(Chromium price used here is the mass-weighted average import value of chromium contained in high-carbon ferrochromium, the major market material.)

Chromium production



World chromite mine production and chromium price.



World chromite ore production and chromium price percent change.

Note: Chromium price used here is the mass-weighted average import value of chromium contained in high-carbon ferrochromium, the major market material.)

Slide 34

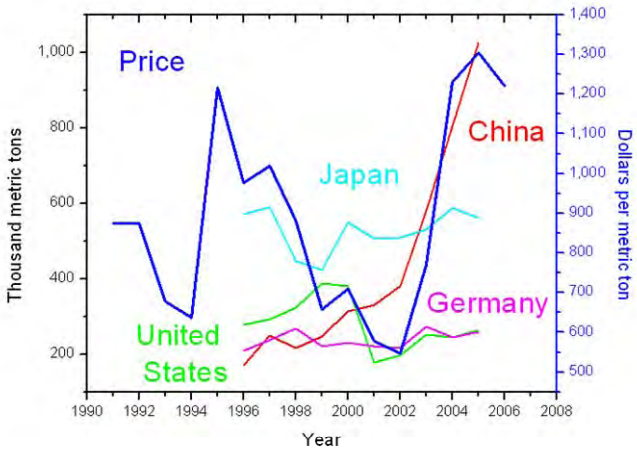
During the 1991-2006 time period, South African chromite ore and ferrochromium smelter production capacity more than doubled while that of other countries declined. Kazakhstan and India became the second and third leading chromite ore producers. Indian chromite ore and ferrochromium production capacity also expanded while that of Albania, Croatia, Japan, Zimbabwe and other countries decreased.

Chromium consumption by the leading consumers (China, Germany, Japan, and the United States) shows that China moved from the least amount of consumption to the greatest amount during this time period and was the only leading consumer that substantially increased its consumption.

Percent change shows that chromium price changes are similar to China's consumption changes.

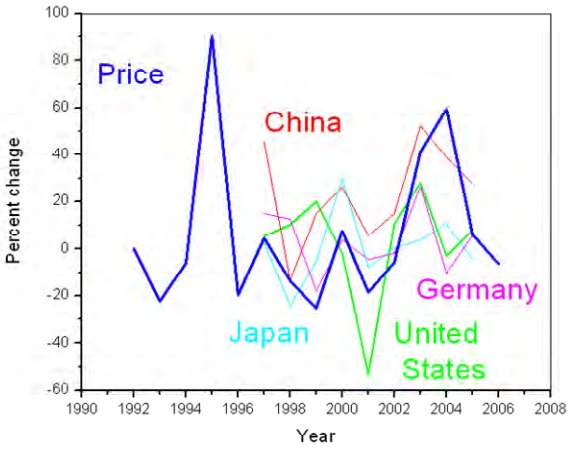
Chromium consumption growth was driven throughout the time period by stainless steel production growth in Asia; growth in Taiwan in the early part of the time period; growth in Korea and India throughout the time period; and growth in China that started in 2000 and dominated the end of the time period. China's growth rate was more than double that of any of the others.

Chromium consumption



Chromium consumption by leading consumers and price.

Chromium consumption by leading consumers and price percent change.

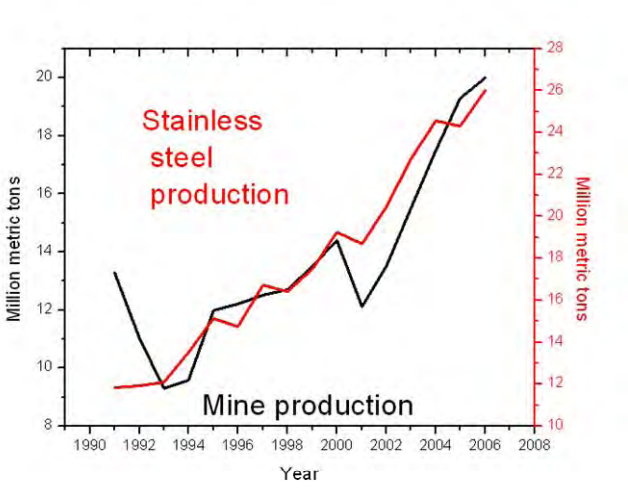


Slide 35

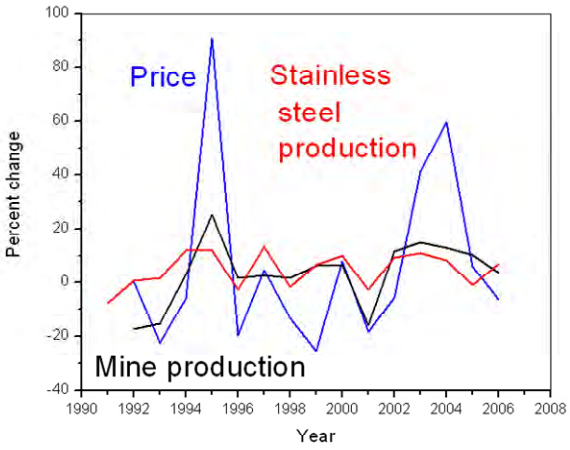
After 1993, chromite mine production and stainless steel production rose similarly.

Percent change of world stainless steel and chromite mine production were similar over the time period. Percent change of chromium price was similar to that of stainless steel production as was chromite mine production.

Chromium and stainless steel



Chromite mine and stainless steel (world) production.

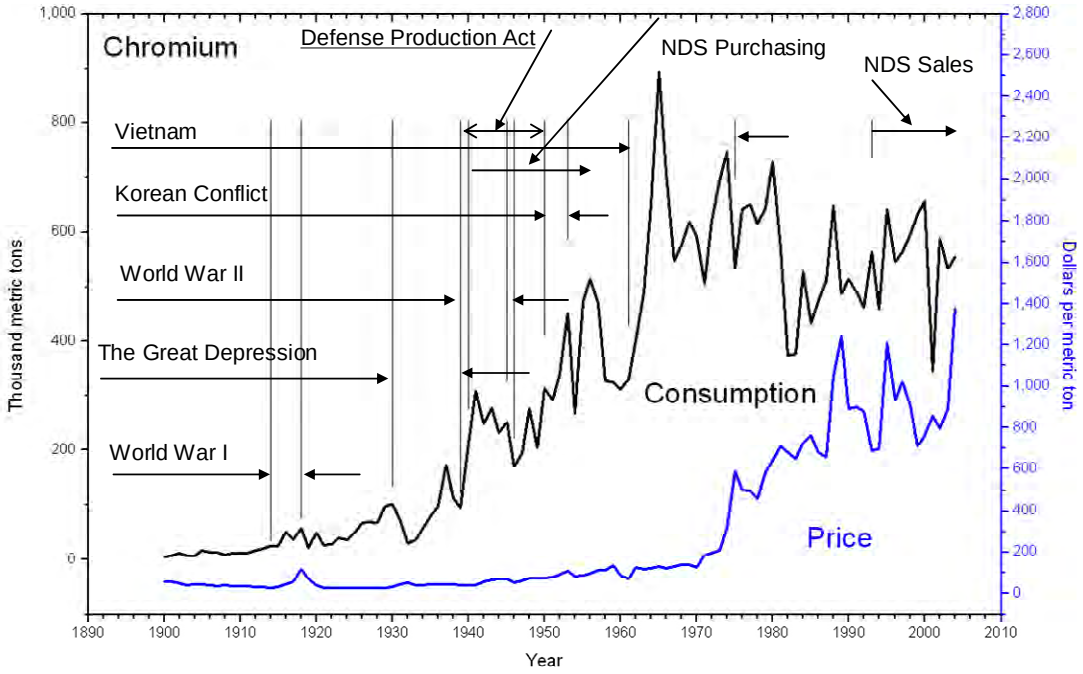


Chromite mine and stainless steel (world) production and chromium price percent change.

Slide 36

Shown here are chromium consumption and price increases associated with WWI, reduced consumption during the great depression, consumption (but not price) increases associated with WWII (because there were price controls).

Chromium consumption and value



Slide 37

Manganese is mined as an oxide ore, converted to ferromanganese or silicomanganese in an electric arc furnace, and then used in the steel production process.

This word slide states: Manganese Mn (1991-2006)

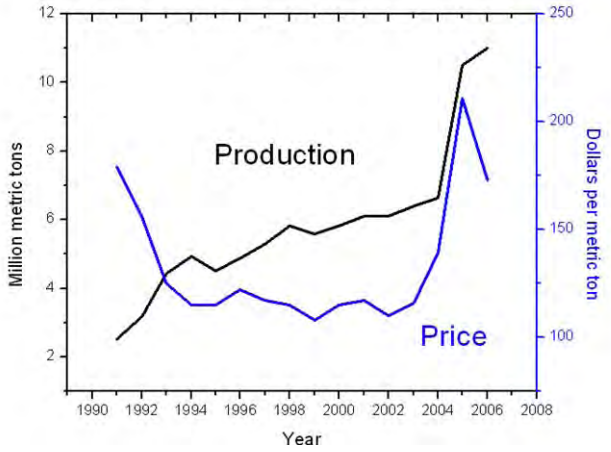
Manganese
Mn
(1991-2006)

Slide 38

From a peak in 1996, manganese price declined until 2003 when it started to increase. Manganese mine production rose steadily over the time period. Manganese price change was not similar to manganese production or steel production until 2002 when steel and manganese production and manganese price started to rise. Manganese production and price peaked in 2005.

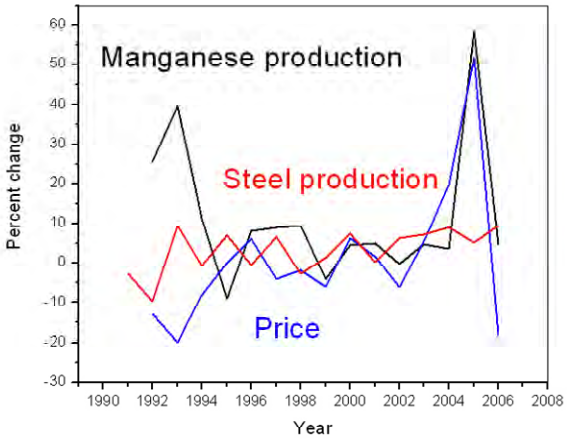
The 2004 rise in manganese price was attributed primarily to increased consumption of manganese ferroalloy by the steel industry coupled with tight ore supplies and rising transportation costs. Steel production expansion in China required bulk cargo ships, port facilities, and coke, the capacity for which ran low in 2005 causing delays and increased cost. It was anticipated that coke and transportation costs would remain high until the bulk cargo carrier fleet and port and loading facilities could be expanded to meet material demand at the increased rate of iron and steel production that resulted from the economic growth in China.

Manganese



Manganese mine production and price.

World manganese mine and steel production and manganese price percent change.



Slide 39

Molybdenum is mined as a sulfide ore, either as a principal product or as a byproduct of copper mining (about 60%). It is roasted to convert the sulfide to an oxide and is subsequently used by the steel industry.

Molybdenum is used in selected grades of stainless and alloy steel. Unlike the other metals considered in this presentation, the United States accounts for a major share of world molybdenum production.

This word slide states: Molybdenum Mo (1991-2006)

Molybdenum
Mo
(1991-2006)

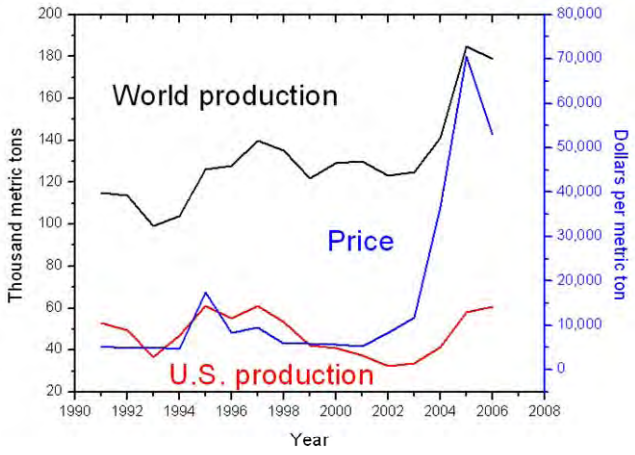
Slide 40

From a peak in 1995, molybdenum price declined until 2001 when it started to increase. Molybdenum mine production predominantly rose after a low in 1993.

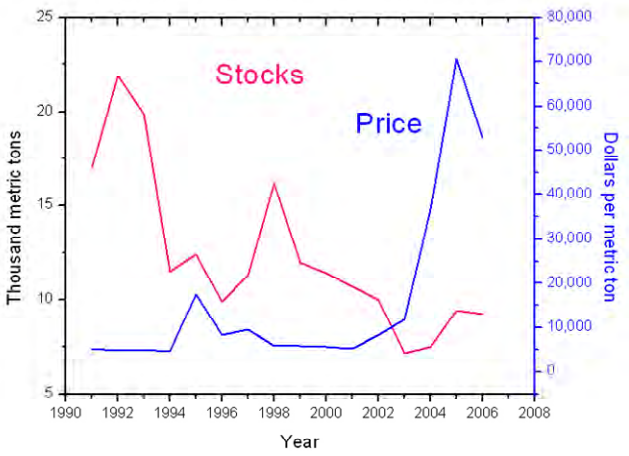
From 1992 to 1994, U.S. industry stocks declined. In 1995, a mine strike at a major producer caused the price spikes of 1995 and 1997. Stocks surged in 1998 in response to those high prices but subsequent low prices discouraged high levels of production and stocks returned to pre-1995 levels.

Starting in 1998, there were several consecutive years of stable, low molybdenum price. During that time period, producers cut back on production and reduced stocks. Prices rose in 2002 and 2003, permitting producers to draw down stocks even further. In 2004, molybdenum demand exceeded supply, and it was realized that increased production was not keeping up with increasing and sustained demand from the steel industry. Stocks were insufficient and price increased dramatically because production was limited by molybdenum roaster capacity.

Molybdenum production



World and U.S. molybdenum mine production and molybdenum price.



U.S molybdenum stocks and molybdenum price.

Slide 41

Nickel is mined in a variety of mineral forms from which nickel extraction is complex and deposit dependent. About one-half of U.S. nickel consumption goes into stainless and alloy steel, and most of the rest goes into nonferrous alloys (copper, brass) and superalloys (nickel-base and nickel containing cobalt-base alloys).

This word slide states: Nickel Ni (1991-2006)

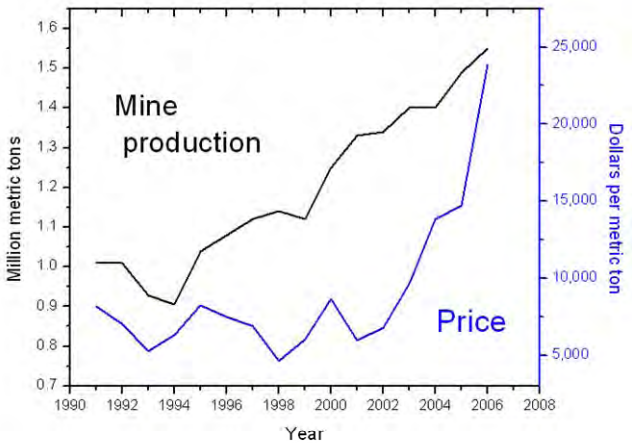
Nickel
Ni
(1991-2006)

Slide 42

From a peak in 1995, nickel price declined until 1998, recovered and then fell back to a low in 2001 after which it started to increase. Nickel mine production rose steadily after a low in 1994.

Following the dissolution of the Soviet Union in 1991, Ni stocks were built up until 1994, even as mine production declined. From 2001-2003, both stocks and price increased suggesting speculative stockpiling. Several consecutive years of nickel demand growth has drawn down London Metal Exchange (LME) stocks to historically low levels.

Nickel production



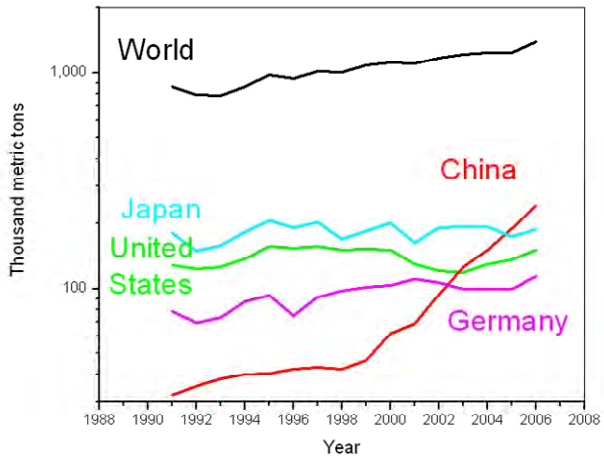
World nickel mine production and nickel price.

Nickel stocks and price.

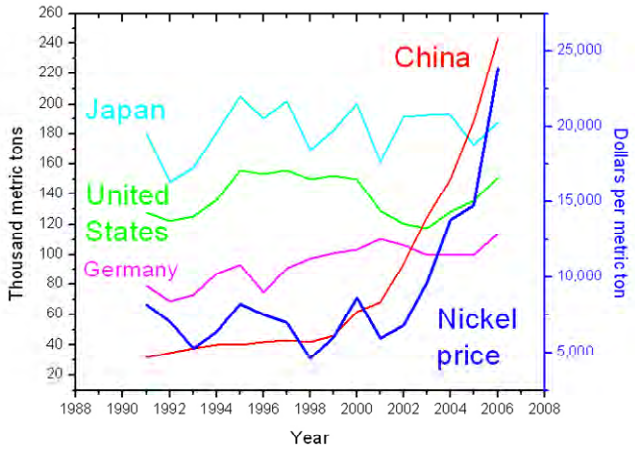
Slide 43

World nickel consumption has been increasing as has that of China and Germany among the leading consumers, shown together here on a logarithmic graph to accommodate the wide range of values on a compact scale. Compared with other leading consumers, China moved from the least amount of consumption to the greatest amount during this time period.

Nickel consumption



World and leading national nickel consumption.



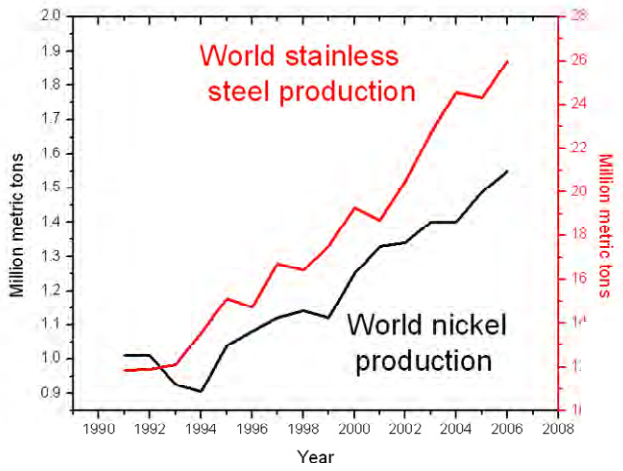
Nickel consumption by leading consumers and price.

Slide 44

Nickel mine production dropped until 1994 while stocks were increasing; however, since 1994, nickel mine and stainless steel production have increased.

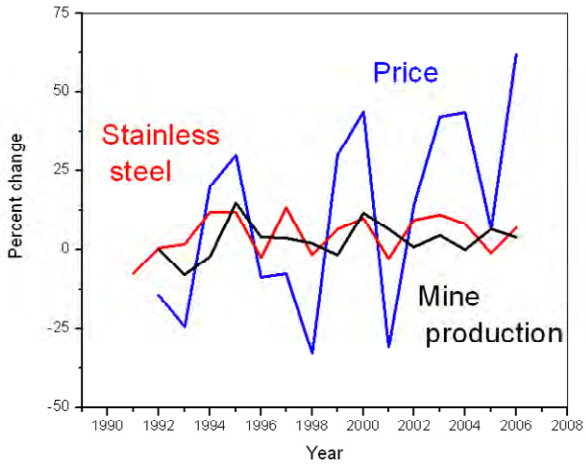
Percent change of nickel mine production and nickel price showed similarities to that of world stainless steel production.

Nickel and stainless steel



Nickel mine and stainless steel (world) production and nickel price percent change.

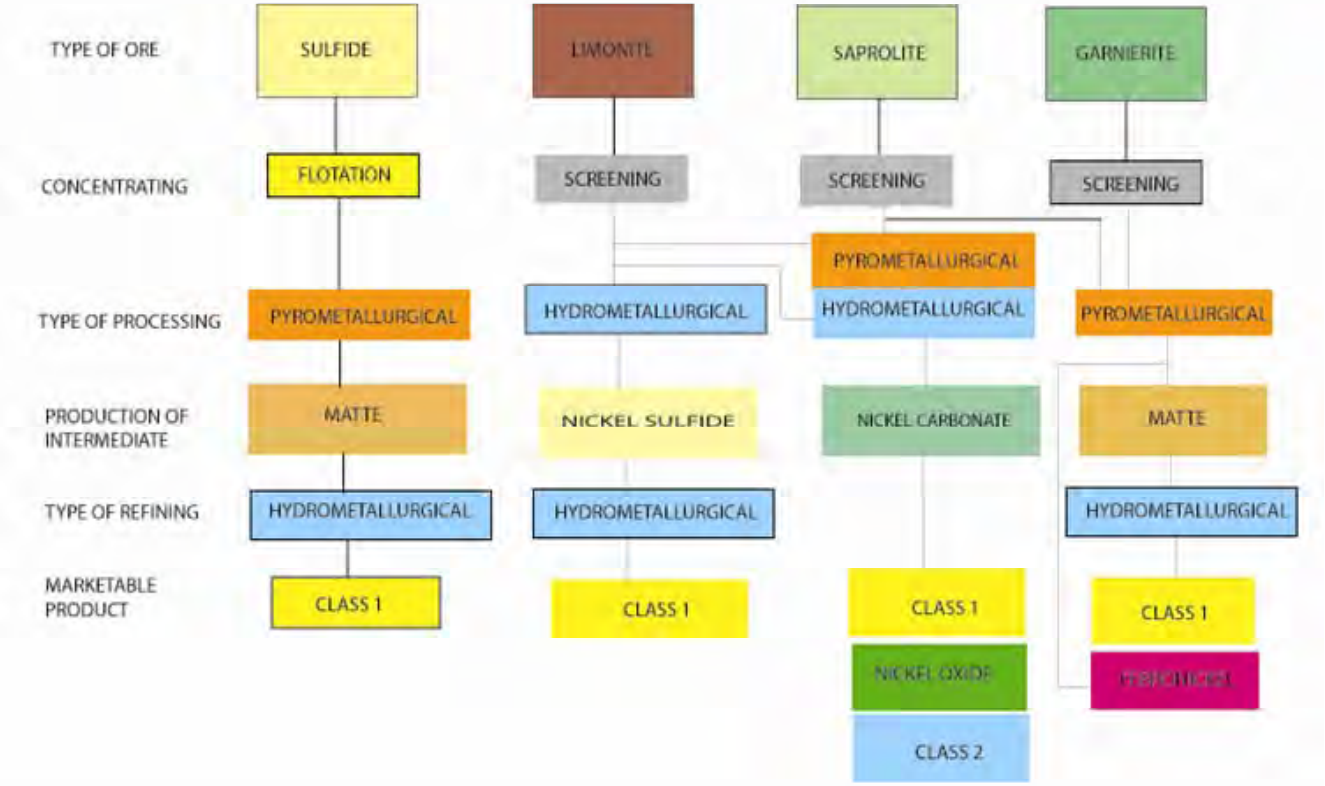
Nickel mine and stainless steel (world) production.



Slide 45

This diagram shows the leading process configurations used to recover nickel from ore and indicates the complexity of recovery that contributes to the high cost of nickel. Historically, the least costly methods and deposits have been exploited. As a result, recovery cost from new deposits usually exceeds recovery cost from historically producing operations.

PROCESSING OF NICKEL ORES



Note: Class 1 products have a nickel content of 99% or greater. Class 2 products, such as ferronickel, have a nickel contentof less than 99%.

Slide 46

This word slide states: Conclusions and observations.

Conclusions and observations

Slide 47

Correlation of metal price with world metal consumption shows that the price of Cr and Ni correlate well with stainless steel consumption; that of Mn and Mo correlate well with steel consumption.

Metal price-world consumption correlation coefficients

	Consumption of:						
Price	Cr	Cu	Mn	Mo	Ni	Stl	SS
Cr	NA	0.97	NA	NA	0.63	0.87	**0.96**
Cu	NA	0.79	NA	NA	0.97	0.83	0.90
Mn	NA	0.73	NA	NA	0.51	**0.80**	0.76
Mo	NA	0.84	NA	NA	0.58	**0.93**	0.88
Ni	NA	0.87	NA	NA	0.98	0.88	**0.99**
Stl	NA	0.94	NA	NA	0.85	0.88	0.94

Note: Most recent 5-year time period. NA – Not available.

Slide 48

Correlation of metal price with national consumption of metal, steel, and stainless steel shows that Cr and Ni price correlate with China's consumption of those metals and that Cu price correlates well with German consumption of that metal. Cr and Ni price correlate well with China's stainless steel consumption. Mn, Mo, and steel price correlate well with Italy's steel consumption.

Metal price-national metal consumption correlation coefficients

	National consumption:								
Price	CN	EU	DE	IN	IT	JP	KR	RU	US
Correlation with national metal consumption.									
Cr	**0.97**		0.58			0.94			0.82
Cu	0.77		**0.96**			0.73			-0.83
Ni	**0.98**		0.58			-0.26			0.96
Correlation with national stainless steel consumption.									
Cr	**0.91**	0.14				0.68	0.65		0.71
Ni	**0.96**	0.14				0.62	0.72		0.71
Correlation with national steel consumption.									
Mn	0.70		-0.11	0.76	**0.93**	0.71	0.46	0.91	0.04
Mo	0.85		-0.34	**0.91**	**0.91**	0.61	0.71	0.83	-0.24
Stl	0.76		-0.19	0.84	**0.90**	0.72	0.62	0.79	-0.17

Note: CN – China. EU – European Union. DE – Germany. IN – India. IT – Italy. JP – Japan. KR – Korea. RU – Russia. US – United States.

Slide 49

Today, China has the second largest economy after that of the United States. China's impact on the mineral and metals markets is greater than its proportional economic size might indicate because China, unlike developed countries, is building infrastructure, a process that is mineral and metal intensive.

Notice that in this list of China's and the United States' share of and rank in the production and consumption of these metals, China ranks mostly number 1, 2, or 3; the United States ranks mostly number 3.

5-year average:	China		US		
Metal	Share	Rank	Share	Rank	Comment
Chromium					
Ore, production	1%	10	--	--	South Africa, #1 (44%)
Ferroalloy, production	9%	3	--	--	South Africa, #1 (44%)
Consumption	9%	2	5%	3	Japan, #1 (11%)
Copper					
Ore, production	5%	7	8%	2	Chile, #1 (35%)
Smelter, production	14%	1	5%	5	Chile, Japan #2, 3 (12%)
Refinery, production	12%	2	9%	3	Chile, #1 (18%)
Consumption	20%	1	14%	2	Japan, #3 (8%)
Manganese					
Ore, production	11%	5	--	--	South Africa, #1 (19%)
Ferroalloy, production	38%	1	--	--	Ukraine, #2 (13%)
Molybdenum					
Ore, production	23%	3	28%	1	Chile, #2 (25%)
Nickel					
Ore, production	4%	8	--	--	Russia, #1 (23%)
Plant, production	5%	6	--	--	Russia, #1 (21%)
Consumption	13%	2	10%	3	Japan, #1 (15%)
Steel (all grades)					
Production	24%	1	10%	3	Japan, #2 (11%)
Consumption	23%	1	13%	2	Japan, #3 (8%)
Stainless steel					
Production	13%	2	9%	3	Japan, #1 (16%)
Consumption	22%	1	11%	3	Japan, #2 (11%)

-- Not among leading countries.

Slide 50

Prices rise, fall, or stay the same, but generally prices have risen over the long term (at least in current dollars) and fluctuate over the short term. Of course, the problem of the manufacturer that consumes these metals is that its ability to delay purchase is limited.

In addition, the magnitude of short-term price variations exceed those of long-term trends. Looking at frequently quoted prices (such as those in the trade journals that report prices daily or weekly, or commodity exchanges that quote prices even more frequently) obscures long-term trends.

Cost of production sets the lower limit for sustainable prices. Supply/demand considerations such as plant openings/closings or unexpected events such as accidents or natural disasters influence short-term price variations. Global events such as wars, recessions, or economic growth influence longer-term trends.

Price fluctuations (measured in percent change) are about the same over most of the time period; however, they are greater in magnitude in recent years because prices are higher in recent years.

This word slide states:

Conclusions / observations

- Prices have risen over the long term.
- Prices have fluctuated over the short term.
- Short term price changes exceed long term price trends.
- Price fluctuations.

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Slide 51

Two major events that affected metal prices during the 1991-2006 time period, dissolution of the USSR in 1991 and growth in China starting about 1998, may be associated with these common trends: production dips that were followed by declining prices in the early part of the time period were coincident with dissolution of the Soviet Union, while rising production after the dip and dramatically increasing prices at the end of the time period were coincident with economic growth in China. Dissolution of the USSR reduced demand and added to supply. Sustained demand growth in China exceeded world supply growth and support infrastructure (electrical power, transportation) causing stock depletion and rising prices.

Data for those metals for which consumption is available (Cr, Cu, Ni, Steel) indicate that China is a major, growing consumer. For those metals for which stocks are available (Cu, Mo, and Ni), stocks are at or near historic low levels. Since China's growth is that of the general economy, one would expect other commodity metals (Mn) to be affected in the same way. (Over the 1991-2006 time period, copper stocks reached the lowest amount in 2005 since 1996; nickel reached the lowest amount over the entire time period in 2006; and Mo stocks reached their lowest level in 2003.)

This word slide states:

Conclusions / observations

- Dissolution of the USSR in 1991 depressed the price of metals.
- Growth of China's economy starting about 1998 coincided with rising metals prices.
- Commodity specific events caused variations on the larger trends.

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Slide 52

In terms of the consumer market, the time when price influences were primarily domestic (i.e., U.S.) has changed to one in which significant consumption is shared. China, in particular, is a growing participant in the metals market. China recently reported 11% GDP growth in the first quarter of 2007, which some economists interpret as an overheating economy. To determine what effect this will have on metal prices, it must be determined whether this growth will be sustained over the long term. Sustained growth in China means sustained demand for these metals and high prices until suppliers and infrastructure expand to accommodate the new level of demand.

If China's growth is sustained, it is expected to be in the 2010-20 time period that metal demand growth decouples from China's GDP growth and then India (which is now growing but from a smaller base, so it has less impact) will become a major metal consumer.

This word slide states:

Conclusions / observations

- The U.S. once dominated the metals market, but no longer.
- China's GDP growth, 11% in Q1 2007
- Price is consensus.

Conclusions / observations

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Slide 53

Some situations that could affect prices in the near future include possible export limitations on chromite ore from India and South Africa; changes in China's economic growth; and continued Indian economic growth.

Voisey's Bay in Canada is ramping up nickel production; Ravensthorpe in Australia and Goro in New Caledonia should start in the next year or so. The steel industry is undergoing restructuring. Global warming is becoming a issue. High fuel prices raise transportation cost. Independent of any metal industry factors, the price of metals changes with the changing value of the U.S. dollar.

This word slide states:

Currents events
with potential price impacts

- India and South Africa may limit chromite ore exports.
- China's economic growth moderates.
- India's economic growth increases.
- Voisey's Bay, Ravensthorpe, & Goro (nickel) coming into production.
- Steel industry consolidation.
- Global warming / carbon sequestration.
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Slide 54

List of references.
This word slide states:
References

American Iron and Steel Institute, Annual Statistical Report.
Consumer Research Unit Limited, Nickel Quarterly Report.
INCO, World Stainless Steel Statistics.
International Chromium Development Association.
International Copper Study Group.
International Iron and Steel Institute, Steel Statistical Yearbook, various years.
International Nickel Study Group.
U.S. Geological Survey, Mineral Commodity Summaries, various years.
U.S. Geological Survey, Minerals Yearbook chapters, various years.
U.S. Geological Survey, Metal Prices in the United States through 1998, at http://minerals.usgs.gov/minerals/pubs/metal_prices/

Dahlman, C.J., 2007, China and India emerging technological powers: Issues in Science and Technology, Spring, p. 45-53.

McCartan, Lucy, Menzie, W.D., Morse, D.E., Papp, J.F., Plunkert, P.A., and Tse, Pui-Kwan, 2006, Effects of Chinese mineral strategies on the U.S. minerals industry: Mining Engineering, v. 58, no. 3, March, p. 37-41.

Meyer, Edward, and Demler, Fred, 2006, Do fundamentals matter anymore?: Man Financial, April, 7 p.

Stundza, Tom, 2007, Purchasing Magazine, Looking ahead to metals through 2010, accesses April 19, at URL http://www.steelforge.com/whitepapers/metals_2010.pdf

References

American Iron and Steel Institute, Annual Statistical Report.
Consumer Research Unit Limited, Nickel Quarterly Report.
INCO, World Stainless Steel Statistics.
International Chromium Development Association.
International Copper Study Group.
International Iron and Steel Institute, Steel Statistical Yearbook, various years.
International Nickel Study Group.
U.S. Geological Survey, Mineral Commodity Summaries, various years.
U.S. Geological Survey, Minerals Yearbook chapters, various years.
U.S. Geological Survey, Metal Prices in the United States through 1998, at http://minerals.usgs.gov/minerals/pubs/metal_prices/

Dahlman, C.J., 2007, China and India emerging technological powers: Issues in Science and Technology, Spring, p. 45-53.
McCartan, Lucy, Menzie, W.D., Morse, D.E., Papp, J.F., Plunkert, P.A., and Tse, Pui-Kwan, 2006, Effects of Chinese mineral strategies on the U.S. minerals industry: Mining Engineering, v. 58, no. 3, March, p. 37-41.
Meyer, Edward, and Demler, Fred, 2006, Do fundamentals matter anymore?: Man Financial, April, 7 p.
STUNDZA, TOM, 2007, Purchasing Magazine, Looking ahead to metals through 2010, accesses April 19, at URL http://www.steelforge.com/whitepapers/metals_2010.pdf

Slide 55

Credit.

This word slide states:

This work is part of the Mineral Resources Program, U.S. Geological Survey.

Robert Callaghan prepared the Minerals Information Team slide.