STAFF RESEARCH STUDY

28

OFFICE OF INDUSTRIES
U.S. INTERNATIONAL TRADE COMMISSION

The Effects of Increasing Chinese Demand on Global Commodity Markets

Forest Products

Petroleum

Ferrous Scrap

Aluminum

June 2006
Publication 3864

U.S. International Trade Commission

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June 2006

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Abstract

China's stunning economic growth in recent years has increased the country's demand for energy and other commodities used by a wide range of industries. This study examines the effects of China's rising demand for commodities on global markets, focusing on crude petroleum, aluminum, forest products, and ferrous scrap. The study explores the factors behind the shifts in trade and prices for each of the four commodities, and finds that the "China impact" on global markets is complex and varies across products. We find that increasing Chinese demand is one factor contributing to the price increases for crude petroleum in recent years, but that global production over the 1995-2004 period more than kept pace with the increased demand from China, mitigating the impact of Chinese demand on global prices. China's expansion of its aluminum and forest products industries has led to increased imports of input products such as wood pulp and alumina. This shift in trade patterns has led to increased global prices for aluminum, while paper prices have remained generally stable. Global market prices for ferrous scrap have increased sharply, reflecting increased demand from China and other countries.

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Executive Summary

China's stunning economic growth in recent years has increased the country's demand for energy and other commodities. The reasons for China's rapidly rising demand and its impact on wider global commodity markets are complex and vary across sectors and products. This study investigates the impact of increasing Chinese demand during the past decade on the global markets for four selected commodities: crude petroleum; unwrought aluminum; forest products, including both paper and lumber; and ferrous scrap. We find that the impact of China on these global markets is more nuanced than generally expected. Rather than sharp price increases for each commodity, we find different effects for the different commodities, depending on the circumstances surrounding each product and market.

Crude Petroleum

- Increasing Chinese demand is one factor contributing to global price increases for crude petroleum in recent years. However, the impact of Chinese demand on prices has been mitigated by the fact that global production over the 1995–2004 period more than kept pace with the increased demand.

- While the petroleum data do not extend beyond 2004, anecdotal evidence suggests that the sharp spikes in crude petroleum prices seen during 2005 and 2006 owe more to one-time, unexpected factors such as the threat of U.N. sanctions on Iran and the supply disruptions related to the hurricanes of 2005 than to the fairly steady, predictable increase in China's demand for petroleum.

Aluminum

- China has increased imports of alumina, the primary input to unwrought aluminum, over the past decade, and has expanded domestic production of unwrought aluminum so much that the country has become a net exporter of the more finished product.

- However, China's increased imports and consumption of alumina have contributed to price increases for that commodity, increasing global prices for unwrought aluminum, and changing the dynamics of the global aluminum market in important ways.

Forest Products

- No central, global market exists for forest products, as it does for aluminum or crude petroleum. However, prices for forest products generally have remained stable even as China's demand for both paper and lumber has increased.

- China has increased its production of wood and paper products and become a net exporter of paper products, through intensive foreign and domestic investment in new sawmills and paper mills. However, since forest resources are not abundant in China, Chinese mills are largely dependent on imports of logs and wood pulp.

- A processing industry dependent on imports of wood pulp and logs is unusual by historical standards, as high transport costs have traditionally encouraged both paper and lumber production in areas close to abundant forest resources. The change is made possible, in part, by the atypical freight transport situation created by the United States' large goods-related trade deficit with China, which has freed up abundant westbound, cross-Pacific freight transport capacity.

Ferrous Scrap

- China's imports of ferrous scrap have increased rapidly over the last decade and particularly since 1999, as a result of strong growth in China's steel mill and ferrous castings industries, and of slower growth in China's production of primary iron and domestic scrap.

- Global market prices for ferrous scrap have also increased strongly, reflecting the growth in global demand, particularly from China, Turkey, and other Asian steel-producing countries.

CHAPTER 1
Introduction

Overview

China's rapid economic growth since its opening to the world in 1978 has resulted in strong demand for a wide variety of commodities. This paper analyzes the effects of increasing Chinese demand on global markets for four selected commodities from 1995 to 2004: crude petroleum, unwrought aluminum, forest products (wood pulp, waste paper, and logs and lumber), and ferrous scrap metal. We find that the effects of China's changing demand have varied significantly, depending on the commodity. In some cases, the effects have been quite different from the global price increases that might be assumed. Growing Chinese demand principally affects global commodity markets through increased Chinese imports, as China's manufacturing capacity has outstripped its domestic supplies of most commodity inputs. Observers have expressed concerns that further increases in Chinese imports may constrict global supplies, leading to higher prices.

Because China has emerged as a key purchaser in many global commodity markets, an examination of China's demand is important to the United States, which competes with China for the same commodities. U.S. firms that rely on imported commodities may be affected by changes in the price and availability of supply. Such market changes will also affect U.S. commodity exports. For example, China's demand for U.S. scrap metal has resulted in rising U.S. exports to China. At the same time, such exports drive up U.S. domestic prices and reduce the availability of some scrap inputs for U.S. producers, potentially leading to higher prices for some U.S. products.[1]

China's increased demand for commodities takes place in the context of the country's rapid economic growth. China's real GDP growth averaged 8.9 percent per year during 1995-2004, and an even faster 12.2 percent during the more recent 1999-2004 period, compared to 4.1 percent for the world and 2.6 percent for the United States during 1995-2004.[2] During 1995-2004, China's GDP as a share of the global total rose from 2.5 percent to 5.0 percent. In contrast, U.S. GDP as a share of the global total rose from 25.2 percent in 1995 to 32.2 percent in 2001, before falling to 28.1 percent in 2005.[3] As illustrated in table 1-1,

[1] See Emergency Steel Scrap Coalition, "Emergency Steel Scrap Coalition Calls for Immediate Action as Scrap Prices Reach New Highs." See also Hearing before the Committee on Small Business, U.S. House of Representatives, 108th Congress, *Spike in Metal Prices: What Does It Mean for Small Manufacturers?* and *Spike in Metal Prices, Part II*.

[2] Compiled from International Monetary Fund, *World Economic Outlook 2005: Globalization and Inflation*, April 2006, 177, 183, and other editions of the *World Economic Outlook*.

[3] International Monetary Fund, *World Economic Outlook Database*, April 2006.

Table 1-1 Select indicators of Chinese economic growth, 1999-2004

Indicator	1999	2004	Compound annual growth rate
			percent
Real GDP (billion dollars)	1,085	1,931	12.2
Real GDP per capita, PPP (actual dollars)	4,141	6,529	9.5
Urban population, share of total (percent)	31	42	6.3
Rural population, share of total (percent)	69	58	-3.4
Petroleum consumption, share of world demand (percent)	6	8	5.9
World imports from China (i.e., China's exports) (billion dollars)	311	751	19.3
Motor vehicle (except motorcycle) production (units)	452,697	5,079,356	62.2

Source: CEIC Database; International Monetary Fund *World Economic Outlook Database* April 2006; Global Trade Information Services, Inc., *Global Trade Atlas*.

China's economic expansion in recent years has been accompanied by rapid growth in its manufacturing sector, as illustrated by the automobile industry, which has helped drive its increasing demand for commodities.

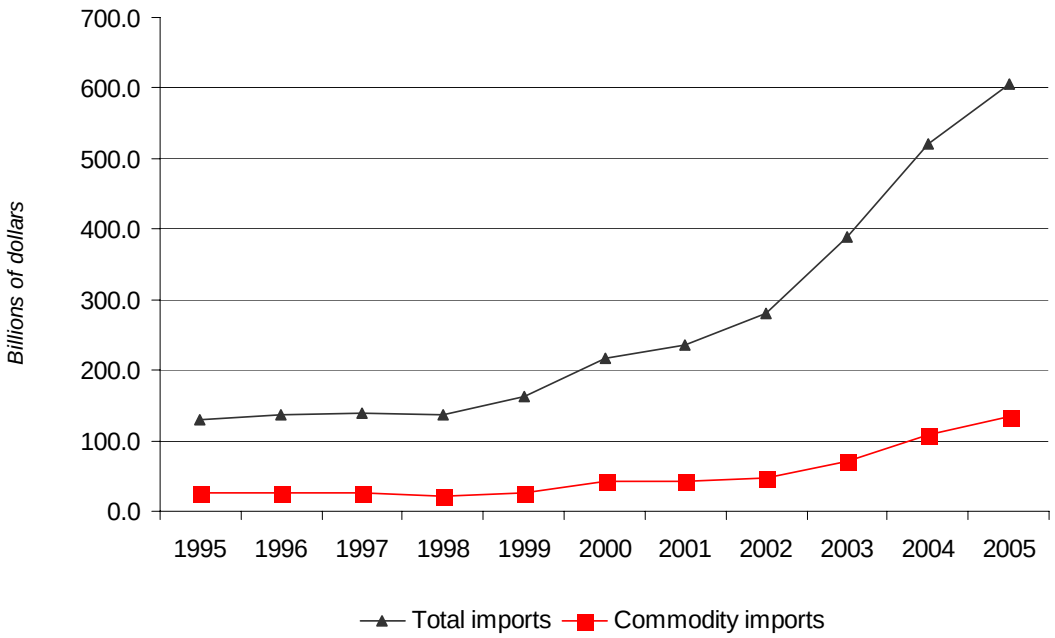
China's total imports and imports of commodities[4] rose rapidly beginning in 2000, in the period leading up to its entry into the World Trade Organization in December 2001 (figure 1-1). Imports of commodities accounted for 19 percent of China's total imports in 1995, falling to 16 percent in 1999, before rising to 22 percent, or $135.4 billion in 2005. Energy commodity imports (crude petroleum, natural gas, and coal) as a share of total commodity imports, by value, rose from 10 percent to 34 percent between 1995 and 2000, fell to 28 percent in 2002, then rose to a peak of 36 percent in 2005. This trend is likely to continue to follow the path of China's economic growth and rising global petroleum prices. In May 2005, the Chinese Government announced its intention to build strategic reserves of minerals such as copper, uranium, and aluminum, in addition to filling strategic reserves of crude petroleum, which may add to China's demand for these commodities.[5]

At first glance, increased demand from China would be expected to contribute to increased global market prices. However, such price increases also depend on the interplay of other market forces, including demand trends in other regions and global supply trends. For instance, the analyses of aluminum and forest products demonstrate that rapid increases in production capacity within China may have outstripped China's domestic demand for those commodities, leading to significant Chinese exports of these downstream products

[4] For the purposes of this study, commodities encompass the products identified by the International Monetary Fund as either commodities or ores and concentrates for metals, as well as packing and printing papers, coke, raw hides, poultry, pork, cement, and uranium.

[5] Areddy, James T. "China, Worried About Resources, To Build Up Its Mineral Reserves," *The Wall Street Journal*.

Figure 1-1 Chinese imports of commodities and total imports, 1995–2005



Source: China Customs import data from Global Trade Information Services, Inc., World Trade Atlas.

and placing downward pressure on global prices.[6] For aluminum in particular, China continues to import alumina, the primary input in aluminum, while its exports of finished aluminum have increased. A similar process is occurring in the Chinese forest products sector, where China has rapidly increased its paper production capacity, and in turn its paper exports. However, this new capacity depends on imported paper feedstocks of waste paper or wood pulp.

The four commodities discussed in this study were selected to illustrate the effects of China's increasing demand across a varied set of commodities which reflect a wide range of market conditions. Chinese demand for crude petroleum has attracted widespread interest in the press and in policy circles in recent years. China's share of world crude petroleum consumption has risen from 4 percent in 1999 to 8 percent in 2004, and total Chinese imports of crude petroleum increased by 931 percent from 1999 to 2005, to $47.9 billion (table 1-2).[7] As the world's largest consumer of crude petroleum, the United States is significantly affected by market factors that determine the price of petroleum. U.S. policymakers thus have a keen interest in the effects of China's rising share in world crude petroleum consumption and the resulting effects on global prices and overall supply. For the other commodities discussed in this study, Chinese imports from the United States and from

[6] "From Accelerator to Brake," *The Economist*, October 6, 2005. Also, in December 2005, an official of China's State Development and Reform Commission stated that 11 sectors were facing, or will face surplus production capacity; the sectors were cement, aluminum, ferralloys, calcium carbide, steel, automobiles, electric power, coal, copper, charcoal, and textiles. Xinhua Online, "China Faces Overproduction in 11 Sectors."

[7] CEIC database.

Table 1-2 Chinese imports of selected commodities

Commodity	HS Heading	China's Imports From the World			China's Imports From the United States		
		1999	2005	Growth, 1999-2005	1999	2005	Growth, 1999-2005
		(Million dollars)		(Percent)	(Million dollars)		(Percent)
Crude petroleum[1]	2709	**4,641.2**	**47,860.5**	**931.2**	[(2)] **39.4**	**0.0**	**-100.0**
Aluminum							
Unwrought aluminum	7601	675.7	1,018.5	50.7	6.8	5.4	-20.6
Aluminum waste and scrap	7602	268.8	1,368.5	409.1	73.1	336.8	360.7
Subtotal	NA	**944.5**	**2,387.0**	**152.7**	**79.9**	**342.2**	**328.3**
Forest products							
Pulp and waste paper	4703, 4707	1,344.2	5,516.5	310.4	248.2	1,489.2	499.9
Logs and lumber	4403, 4407	1,908.0	4,745.0	148.7	103.1	373.6	262.5
Packaging and printing papers	4804, 4805, 4810, 4811	2,816.7	2,948.6	4.7	519.9	460.2	-11.5
Subtotal		**6,069.0**	**12,310.1**	**117.7**	**871.2**	**2,323.0**	**166.6**
Ferrous scrap	7204	**316.7**	**2,607.8**	**723.4**	**35.3**	**829.2**	**2,249.0**

Source: China Customs, from Global Trade Information Services, Inc., *World Trade Atlas*.

[1] Both the quantity and value of China's imports of crude petroleum increased significantly during the period. However, because of the fluctuations in the world price of crude petroleum, China's imports increased 931 percent by value, but only 600 percent by quantity (see chapter 2 for further detail).

[2] These data reflect official Chinese import statistics. However, the United States does not supply crude petroleum to China. U.S. exports of crude petroleum to any country have been prohibited since 1973, except as approved by the U.S. Government. Canada has been the only consistent market for these exports. In May 1996, the President determined that allowing exports of Alaskan North Slope (ANS) crude to certain Pacific Rim nations (Japan, Taiwan, South Korea) was in the national interest, thus ending the 23-year ban on ANS crude exports. However, the President can impose new export restrictions in the event of severe crude petroleum supply shortages.

the world have increased rapidly for the segments of each commodity market that are used as manufacturing inputs. For instance, Chinese imports of aluminum scrap from the United States increased 361 percent during 1999-2005, while imports of unwrought aluminum, the more finished product, declined by 21 percent. Similarly, Chinese imports of wood pulp and waste paper from the United States increased by 500 percent over the same period, while imports of finished paper declined by 12 percent.

In an effort to secure access to important raw materials and commodities, the Chinese Government and Chinese state-owned enterprises (SOEs) are increasing their presence in foreign policy, diplomacy, economic policy, and trade matters in a host of foreign countries.[8] The Chinese Government implemented its "Go Out" policy in 2003 to promote outbound

[8] Zweig, David and Bi Jianhi, "China's Global Hunt for Energy."

foreign direct investment (FDI), with a particular interest in the acquisition of commodities. The "Go Out" policy has, for the most part, resulted in the acquisition of petroleum and other mining sector resources. In 2004, more than half of Chinese outbound direct investment went to the mining sector, primarily into exploration for oil and natural gas resources.[9]

The three large state-owned oil firms, China National Petrochemical Corporation (Sinopec), China National Petroleum Corporation (CNPC/Petrochina), and China National Offshore Oil Corporation (CNOOC), have invested in at least fourteen countries, with the goal of ensuring China's supplies of energy and mineral resources.[10] In the non-oil resource sector, SOEs such as China Minmetals, Aluminum Corporation of China (Chalco), and Baoshan Iron and Steel Co. (Baosteel) are central to the country's strategy of acquiring non-energy resources and safeguarding supplies. Aside from direct ownership of many Chinese-based multinational corporations, the Chinese government also supports overseas investment by Chinese firms through its Export-Import Bank, which devoted more than one-third of its resources to such investment projects in 2005, a significant shift from previous years.[11]

In 2004, China's realized investment stock in Latin America[12] totaled $448.5 million, with investment in Mexico accounting for the majority, followed by Brazil.[13] In a speech to the Brazilian Congress in November 2004, President Hu of China stated that China would invest $100 billion in Latin America over the next decade, including $20 billion in Argentina.[14] Energy concerns have been notable in China's investment plans for Latin America.

China's realized investment stock in Africa totaled $899.6 million in 2004, with Sudan representing the majority of this investment, followed by Zambia.[15] According to press reports and industry analyses, Chinese firms in pursuit of natural resources, particularly metals, are increasing their presence across Africa, even in remote and politically unstable locations that have previously attracted little foreign direct investment from other countries, including Gabon, the Central African Republic, and the Democratic Republic of the Congo. According to observers, Chinese firms in Africa often have been willing to barter for access to minerals, building community facilities such as football fields and infrastructure in return for access.[16]

Russia is China's leading investment destination in Europe, with China's realized investment totaling $77.3 million in 2004. Chinese investment totaled $5.3 million in Kyrgyzstan, $5.0 million in Tajikistan, $2.3 million in Kazakhstan, $1.1 million in Uzbekistan, and $200,000 in Azerbaijan, in 2004.[17]

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[9] China Ministry of Commerce (MOFCOM), *China's 2004 Outbound FDI Statistical Report.*

[10] The firms have invested in Chile, Ecuador, Kazakhstan, Syria, Azerbaijan, Sudan, Iran, and a wide range of other developing countries. UNCTAD, "China: An Emerging FDI Outward Investor." Xinhua, "Chinese, Indian Oil Firms Agree to Buy Syrian Assets of Petro-Canada."

[11] U.S. Dept. of State telegram, "China Shaping its "Go Out" Policy," U.S. Embassy Beijing, message reference No. 03327, March 2, 2005.

[12] Official Chinese investment data is presented in terms of approved investment, which is licensed but has not necessarily taken place, and realized investment, for which capital has been transferred out of China.

[13] China Ministry of Commerce (MOFCOM), *China's 2004 Outbound FDI Statistical Report.*

[14] Congressional Research Service (CRS) Report for Congress, "China's Growing Interest in Latin America."

[15] China Ministry of Commerce (MOFCOM), *China's 2004 Outbound FDI Statistical Report.*

[16] U.S. Dept. of State telegram, "South Africa: De Beers Comments on Chinese, Russian Minerals Interests."

[17] China Ministry of Commerce (MOFCOM), *China's 2004 Outbound FDI Statistical Report.*

Organization

For each of the four commodities discussed in this study, the analyses in chapters 2 through 5 present an overview of supply and demand factors, both globally and within China, and a discussion of price and trade trends between 1995 and 2004. China's role in global supply and demand is also discussed in detail. For each commodity, the study assesses the effects of increasing shipments to China on global market prices, trade and production patterns, and overall supply, including the role of Chinese and major foreign direct investments.

For two of the commodities, forest products and aluminum, the analysis has additional complexity. Global trade and prices for these commodities are dependent upon the mix of basic inputs versus semi-finished inputs needed by producers. For aluminum, for example, Chinese producers may import bauxite (the base ore from which aluminum is made), alumina (ore that is more refined), scrap aluminum (to be remelted), or unwrought aluminum (aluminum metal that has been smelted and is ready for subsequent processing into more finished products) or all of those inputs. Demand for each of these is dependent upon countries' natural endowments in minerals and energy production, as well as global prices. Likewise in forest products, forest resources and scrap paper recycling are factors in global demand and supply. The analyses of these commodities includes the effects of these input factors on the respective markets.

As a further attempt to broaden the analyses of these commodity markets, the appendix presents a review of the existing economic literature related to supply and demand for each commodity. There is little existing literature directly addressing the role of China in each market. Instead, the review assesses the existing estimates of supply elasticities and other supply and demand factors for the four commodities, in an effort to determine the potential effects of China's demand changes on the market prices for each commodity.

The study concludes by offering suggestions for further research related to China's demand for commodities. Possibilities include constructing forecasts of China's commodity demand, and analyzing the effects of macroeconomic and global political conditions or of foreign direct investment. Further insight may also be gained by examining the effects of China's currency regime and China's free trade agreements on global demand for commodities.

CHAPTER 2
Crude Petroleum

Summary of Conclusions

China's growing prominence as an energy consumer has generated concerns that China's rising domestic demand could decrease crude petroleum availability on the world market, thereby constricting supply and further raising prices. However, our research indicates that while China's overall demand is rising, global production is keeping pace, as world reserves and supplies of crude petroleum are sufficient at current prices to absorb this increase. During 2004, China accounted for 8 percent of the world's consumption of crude petroleum compared with the more than 25 percent consistently accounted for by the United States, the world's leading consumer of crude.

China's large population and rapid economic development are placing greater demands on its scarce crude petroleum reserves and under-invested production and refining capacity. As of January 1, 2006, China accounted for about 1 percent of the world's proven reserves of crude petroleum, 5 percent of the world's production of crude petroleum, and 5 percent of the world's total refining capacity.[1] China's growing presence as an energy consumer and its aggressive FDI strategy have generated concerns about the effects on global supply and price.[2] Although China's increasing demand (stemming from strong economic growth, a shift toward non-coal sources of energy, and increased need for transportation fuels) does play a role in the world crude petroleum market, experts disagree as to how long this increase in demand from China will continue. It is likely that continued rising demand from the United States will have a stronger impact on the world market than demand growth from China.

China's dependence on imported crude petroleum is expected to increase from 45 percent of total domestic demand in 2004 to 80 percent by 2030.[3] In its attempts to lessen dependence on imported crude petroleum, China is developing its offshore reserves and investing abroad. China has been willing to invest in politically unstable countries, such as Sudan, Kazakhstan, and Angola, that are generally avoided by the large multinational petroleum companies. To date, China's total investment in overseas crude petroleum operations is relatively small, amounting to about 400,000 barrels per day (b/d) in 2004, which accounts for only about 10 percent of China's total imports of crude petroleum and less than 0.5 percent of global crude petroleum production. In contrast, outward investment by the top three U.S. companies alone accounts for 35 percent of total U.S. imports.

[1] *Worldwide Report*, Oil and Gas Journal, December 19, 2005 and March 16, 2006.
[2] U.S. Department of Energy, *Energy Policy Act 2005*.
[3] U.S. Department of Energy, *International Energy Outlook 2005*, July 2005.

Demand

Factors Broadly Affecting Demand

Crude petroleum has limited uses in its natural state but is critical as the feedstock for refined petroleum products including distillate and residual fuel oils,[4] motor fuels,[5] liquefied petroleum gas,[6] naphtha,[7] kerosene, and gasoil.[8] Economic growth and increasing global population in emerging economies, including China, will reportedly drive increasing demand for crude petroleum in the coming years.[9] As discussed in chapter 1, increased consumption of petroleum products is projected in emerging economies that experience strong sustained economic growth, as such growth increases demand for petroleum products in expanding transportation sectors, as well as in the industrial sectors of the economy.[10] The transportation sector accounts for approximately 60 percent of the projected increases in global crude petroleum consumption between 2002 and 2025.[11] The industrial sector accounts for approximately 28 percent of the projected increases in world crude petroleum consumption, for use primarily as feedstock for petrochemical production.

Demand for Crude Petroleum in China

Since 1978, China's economy has grown at approximately 9 percent annually. Much of the increased demand for petroleum products is attributable to the high energy intensity (energy consumption per unit of GDP) of China's relatively inefficient industrial sector, attempts by the government to shift toward non-coal sources of energy,[12] and China's increased need for

[4] Distillate fuel oils are petroleum fractions used as diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, and off-highway engines, such as those in railroad locomotives and agricultural machinery. Distillate fuel oils are also used for space heating and electric power generation. Residual fuel oils are the heavier oils that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations. Products known as No. 5 are Navy Special, for use in steam-powered vessels in government service and onshore power plants; No. 6 includes Bunker C fuel oil used for commercial and industrial heating, for electricity generation, and to power ships.

[5] Motor fuels are gasolines, jet fuels, and blending stocks.

[6] Liquefied petroleum gases include ethane, ethylene, propane, propylene, normal butane, butylene, and isobutane produced at refineries or natural gas processing plants, including plants that fractionate new natural gas plant liquids.

[7] Naphtha is a petroleum fraction containing aliphatic hydrocarbons (organic chemical compounds of hydrocarbon and carbon) with an approximate boiling range between 122 and 140 degrees Fahrenheit; it is the intermediate product produced between gasoline and kerosene and contains components of both.

[8] Gasoil is a mixture of gas, oil, and water that has yet to be separated by further refinery processes.

[9] U.S. Department of Energy, *Energy Policy Act 2005*, 1; and Daniel Yergin, "Ensuring Energy Security."

[10] U.S. Department of Energy, Energy Information Administration, *International Energy Outlook 2005*, 26. In contrast, recessions can result in declining demand. For example, consumption declined in Eastern European and former Soviet Union countries following the collapse of the Soviet Union in the early 1990s, from 10 million b/d to 5.3 million b/d in 1997, as the region's gross domestic product (GDP) contracted by almost one-third. Ibid., 27.

[11] Ibid., 9.

[12] Coal is the largest component of China's energy consumption, accounting for about 63 percent of all energy consumed. Coal consumption has remained roughly unchanged during the period. The Chinese government is attempting to move China's energy mix toward greater reliance on non-coal sources of energy, mostly due to environmental concerns. Energy Information Administration, *China Environmental Issues*.

transportation fuels.[13] Moreover, in the past 20 years per capita incomes in China have increased, and the country has experienced a significant rise in its middle class, furthering China's energy needs as individuals increase automobile usage and air travel.[14]

During 2006, Chinese demand for crude petroleum is expected to grow by 6.5 percent,[15] with expected annual growth of 3 percent over the next 25 years. It is forecasted that petroleum will account for 35 percent of the increase in China's primary energy demand, as factories expand and automobiles become more prevalent.[16] The number of vehicles in China is expected to increase from 24 million to as many as 140 million by 2020, with demand for motor fuels expected to grow by 8 to 10 percent in 2006 alone.

China's Demand in Global Context

Between 1995 and 2004, China increased its share of global crude petroleum consumption from 4.8 percent to 7.8 percent of total world petroleum consumption, bypassing Japan to become the second largest consumer of crude petroleum in 2004, 2005, and during January-March 2006. Although China is the second-largest overall energy consumer after the United States, Chinese per capita energy consumption is only one-eighth of that in the United States.[17] The top industrialized crude petroleum consuming countries experienced marginal declines in their market shares of total consumption, while developing countries' market shares increased during the 1995-2004 period (table 2-1).

Table 2-1 Crude petroleum consumption by major sources: 1995, 1999, and 2004[1]

Country	1995		1999		2004	
	1,000 b/d	Percent	1,000 b/d	Percent	1,000 b/d	Percent
United States	17,725	25.3	19,519	25.7	20,815	25.1
China	3,363	4.8	4,364	5.8	6,427	7.8
Japan	5,676	8.1	5,698	7.5	5,411	6.5
Russia	2,976	4.3	2,538	3.3	2,758	3.3
Germany	2,882	4.1	2,838	3.7	2,645	3.2
India	1,575	2.2	2,031	2.7	2,448	3.0
Canada	1,819	2.6	2,027	2.7	2,279	2.8
Brazil	1,788	2.6	2,130	2.8	2,157	2.6
South Korea	2,008	2.9	2,084	2.7	2,151	2.6
France	1,919	2.7	2,029	2.7	2,078	2.5
All other countries	28,287	40.4	30,572	40.3	33,654	40.6
World Total	70,018	100.0	75,830	100.0	82,822	100.0

Source: Energy Information Administration, *International Energy Annual 2003.*

[1] 2004 production data and corresponding market shares are derived from 2003-2004 growth rates as published in *BP Statistical Review, 2005*.

[13] U.S. Department of Energy, *International Energy Outlook 2005*, 25 and *Country Analysis Briefs: China*, (August 2003): 7–8 and U.S. Department of Energy, *Energy Policy Act 2005*, 7.

[14] U.S. Department of Energy, *Energy Policy Act 2005*, 7.

[15] International Energy Agency, *Oil Market Report*.

[16] "Made for Each Other," 19–20; and Peter S. Goodman, "Oil Exports Leave China."

[17] U.S. Department of Energy, *Energy Policy Act 2005*, 2.

Supply

Factors Broadly Affecting Supply

During the 1995-2004 period, world proved reserves of crude petroleum increased by almost 16 percent to nearly 1.2 billion barrels.[18] World refinery capacity increased by almost 11 percent during the 1995-2004 period to 82.3 million b/d.[19] The global market for crude petroleum exhibited strong growth during 1995-2004. Global production and consumption of crude petroleum[20] both exhibited similarly increasing trends, although consumption slightly outpaced production during the 1995-2004 period.[21] Global production of crude petroleum increased 16 percent to 72.3 million b/d in 2004 from 1995 production levels.[22] During the same period, global consumption of crude petroleum increased to 82.8 million b/d in 2004, an increase of approximately 18 percent from 1995 consumption levels. Compound annual growth rates (CAGR) of worldwide production and consumption of crude petroleum over 1995-2004 were 1.49 and 1.69 percent, respectively, and indicate approximately even production growth relative to consumption growth over the period.

A number of factors can affect the supply of crude petroleum and associated downstream petroleum products, including upstream and downstream capacity and capabilities, as well as any disruption in production caused by war, natural disasters, labor disputes, or accidents. For example, shut-in[23] crude petroleum production was equivalent to over 27 percent of the daily crude petroleum production in the Gulf of Mexico (GOM) in early 2005, but declined to approximately 22 percent or about 1.5 million b/d immediately following hurricanes Katrina and Rita.[24]

Supply of Crude Petroleum in China

China's petroleum sector historically consisted entirely of a few state-owned firms. Private Chinese companies were permitted into the market in 2001, and Chinese-foreign joint ventures have been permitted since 1995. The petroleum industry in China is majority-owned and operated by the Chinese government, which also sets the price that the domestic industry pays for crude petroleum. Responsibility for the energy sector in China is divided among several different agencies, but is led by the National Development and Reform

[18] *BP Statistical Review 2005*.

[19] Energy Information Administration, *International Energy Annual 2003*. Distillation capacities include refining capacities for other petroleum-based downstream products.

[20] For world crude petroleum production for 1995-2003, see Energy Information Administration, *International Energy Annual 2003*. Crude petroleum production figures include lease condensate, which is recovered as a liquid from natural gas wells in lease or field separation facilities and later mixed into the crude stream.

[21] Data for crude petroleum consumption reflect additional inputs compared to crude petroleum production data, so consumption is always larger. Consumption data include certain refined petroleum products (such as liquefied petroleum gases and bunker fuels) and inherent refinery losses and gains.

[22] 2004 world crude petroleum production figures are estimates based on the annual change in production between 2003 and 2004 as published in *BP Statistical Review 2005*. Crude petroleum production figures as published in *BP Statistical Review 2005* include crude oil, shale oil, oil sands, and natural gas liquids.

[23] Shut-in production refers to a well that has been closed down temporarily for repair, cleaning out, building up reservoir pressure, or because of a lack of market demand.

[24] Minerals Management Service, "Hurricane Katrina/Hurricane Rita Evacuation and Production Shut-in Statistics Report as of Thursday, December 29, 2005"; "Hurricane Katrina/Hurricane Rita Evacuation and Production Shut-in Statistics Report as of May 1, 2006," found at http://www.mms.gov.

Commission (NDRC).[25] The Department of Price, housed within the NDRC, sets artificially low prices in an effort to build its industrial base.[26] While the Department of Price has recently raised crude petroleum prices, such increases have not kept pace with world market prices.[27] The Chinese government policy of keeping crude petroleum prices below the market level has encouraged crude petroleum exports and has led to domestic energy shortages.[28] Regulatory oversight of the industry is the responsibility of the State Energy Administration (SEA), which was created in early 2003. Two new Chinese government bodies were created during 2005 to enhance national coordination of strategic energy matters: the National Energy Leading Group (NELG) and the National Energy Office (NEO). The NEO will be housed within the NELG.[29]

China's petroleum industry has undergone major changes over the last decade. In 1998, the Chinese government reorganized most state-owned crude petroleum and natural gas assets into 2 vertically integrated firms – CNPC, operating in the north and west, and Sinopec, concentrated in the south and east.[30] CNPC has a greater focus on crude petroleum production while Sinopec focuses more heavily on refining; however, both companies perform both functions. Other major state sector firms in China include CNOOC, China National Oil & Gas Exploration & Development Corp. (CNODC), and China National Star Petroleum (Star). CNOOC handles offshore exploration and production and accounts for more than 10 percent of China's domestic crude petroleum production.

Crude petroleum production within China is expected to decline slightly through 2025, to about 3.5 million b/d.[31] Onshore fields currently account for about 85 to 90 percent of China's known reserves, with the largest fields located in the northeast.[32] Daqing, the largest field in China, has produced more than 1 million b/d for more than 20 years; this level is expected to drop by 2010. Reserves at Daqing are already 50 percent extracted.[33] Most new onshore exploration is taking place in the western part of the country. The Chinese expect to explore and develop the Tarim Basin in the northwest.[34] Geologists believe that the Basin contains several small-and-medium size crude petroleum deposits.

As Chinese onshore oilfields have slowly declined and prospects for future exploration and development are not strong, offshore crude petroleum development has increased. Offshore crude petroleum now accounts for a half million b/d in China, an increase of more than 200 percent since 1995. CNOOC is exploring Bohai Bay, the South China Sea, and the East China Sea for possible development; the majority of offshore crude petroleum exploration is concentrated on the Bohai Bay and in the Pearl River area in southeastern China.[35]

The Chinese government and the national petroleum companies have set priorities to achieve high levels of domestic crude petroleum production and distribution and build a strategic

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[25] U.S. Department of Energy, *Energy Policy Act 2005.*

[26] Guth and Ginsberg, "Energy Use in China."

[27] U.S. Department of Energy, *China*.

[28] International Energy Agency, *Oil Market Report*.

[29] U.S. Department of Energy, China.

[30] "Chinese Wells," Petroleum Economist 71, no. 12, (December 2004): 16–17.

[31] Energy Information Administration, *International Energy Outlook*, 2005, 33.

[32] U.S. Department of Energy, *An Energy Overview*.

[33] PennWell Corp., *International Petroleum Encyclopedia*, 153; McCreary and Loose, *China's Energy Resources and Supply* and Daniel Yergin, "Ensuring Energy Security" *Foreign Affairs*, March/April 2006.

[34] U.S. Department of Energy, *An Energy Overview*; and International Energy Agency, *China's Worldwide Quest for Energy Security, 2000.*

[35] "Bohai Bay Bonanza," 14; and Office of Fossil Energy, *An Energy Overview.*

petroleum reserve. The Chinese government hopes to stabilize production in the eastern part of the country at current levels, increase production offshore and at new fields in the west, and develop the infrastructure required to deliver western crude petroleum and gas to consumers in the east. Success will depend on doubling China's existing 14,478 kilometers of pipeline, planned for 2015.[36] China National Star and CNOOC began construction on a national strategic petroleum reserve in 2005. The reserve will be located near major refineries and will consist of 3 tank farms, to be built and filled in phases, beginning with 100 million barrels of storage filled by 2008.[37]

Due to China's growing dependence on crude petroleum imports to meet its energy needs, Chinese state-owned oil companies have actively invested in exploration and production abroad since the mid-1990s. By 2004, China's total investment in overseas crude petroleum operations amounted to about 400,000 b/d, in 44 countries.[38] China has traditionally been willing to invest in unstable countries, such as Sudan, Kazakhstan, and Angola, where Western oil companies do not yet dominate investment. China has reportedly stationed four thousand nonuniformed troops in Sudan to protect its crude petroleum interests.[39] China's total investment in overseas crude petroleum operations is expected to rise to 1.4 million b/d by 2020.[40] Although there is much attention given to Chinese firms' investments in overseas crude petroleum, these investments accounted for less than 10 percent of China's total crude petroleum imports as of mid-year 2005.[41]

Among other transactions (see table 2-2), CNPC acquired a 60-percent stake in the Kazakh crude petroleum firm Aktobemunaigaz, which came with a pledge from CNPC to invest significantly in the company's future development over the next twenty years.[42] CNPC has also acquired crude petroleum assets in Angola, Azerbaijan, Cambodia, Canada, Indonesia, Iran, Iraq, Myanmar, Oman, Peru, Russia, Sudan, Syria, Thailand, Turkmenistan, and Venezuela.[43] CNPC's 2005 purchase of PetroKazakhstan will help to meet demand in western China, through a pipeline to western China that CNPC is building with Kazakh-owned KazMunaiGaz.[44] CNPC is also hoping to win a joint bid with India's Oil and Natural Gas Corporation (ONGC) to purchase a 38-percent share of Syria's largest petroleum

[36] Energy Information Administration, *China*; Central Intelligence Agency, "China;" and Office of Fossil Energy, *An Energy Overview*.

[37] Energy Information Administration, *China*; and Logan, *Annual Energy Outlook for 2005*.

[38] U.S. Department of Energy, *Energy Policy Act 2005*, 28; and American Enterprise Institute, *CNOOC's Bid for UNOCAL*.

[39] Zweig and Jianhai, "China's Global Hunt for Energy," 32.

[40] Logan, *EIA's Annual Energy Outlook for 2005*.

[41] Energy Information Administration, *China*.

[42] Energy Information Administration, *China*.

[43] "Opportunity NOCs," 21-22.

[44] "China Makes a Huge Bid for Oil."

Table 2-2 China's investment in overseas crude petroleum assets: Selected joint ventures and other arrangements, 2004–2005

Date	Chinese Company	Overseas Company	Country	Other Details of Transaction
January 2004	Shengli Oilfield Junwei Petroleum -Tech Development Co. Ltd.	Big Sky Energy Kazakhstan Ltd.	Kazakhstan	50 percent acquisition of crude petroleum and natural gas extraction services
April 2004	CNPC	Enbridge	Canada	$2 billion pipeline to carry crude petroleum to the western coast of Canada for shipment to China
June 2004	CNPC	Uzbekneftegaz	Uzbekistan	UzCNPC Petroleum formed, a joint venture of petroleum and natural gas field services
August 2004	Sinopec	Petroleo Brasileiro SA	Brazil	Crude petroleum exploration joint venture
October 2004	Sinopec	National Iranian Oil Company	Iran	Liquefied natural gas purchases for the next 30 years and oilfield development in exchange for 150,000 b/d of crude petroleum at market prices for twenty-five years. This transaction is valued at $70 billion.
January 2005	Shengli Oilfield Junwei Petroleum - Tech Development Co. Ltd.	Big Sky Energy Kazakhstan Ltd	Kazakhstan	Joint venture for crude petroleum production in three blocks in the Caspian region of Kazakhstan
February 2005	CNPC, CNODC	State Oil Company of the Azerbaijani Republic	Azerbaijan	Salyan Oil Operating Company formed, a joint venture of crude petroleum extraction services. Ownership share was raised to 25 percent in November 2005.
April 2005	CNOOC	MEG Energy Corp.	Canada	17 percent share in oil sands project in Alberta
May 2005	Sinopec	Synenco Energy	Canada	40-percent stake in Northern Lights oil sands project
August 2005	CNPC	PetroKazakhstan Inc.	Canada (assets in Kazakhstan)	500 million barrels in crude petroleum reserves valued at $4.18 billion
September 2005	Andes Petroleum Co. (joint venture that includes CNPC)	EnCana Corp.	Ecuador	Crude petroleum and pipeline assets with 75,000 b/d valued at $1.42 billion
December 2005	CNOOC	Yuganskneftegaz	Russia	Minority stake in crude petroleum and natural gas extraction services firm

Sources: Compiled with information obtained from Zephyr Mergers and Acquisitions database and interviews with industry officials, November–December 2005.

producer, Al Furat Production Company.[45] Sinopec has begun seeking to purchase overseas upstream assets and now has assets in Algeria, Azerbaijan, Indonesia, Libya, Oman, Nigeria, Tunisia, and Yemen.[46] CNOOC has overseas investments in Australia and Indonesia.[47] China's current focus for securing new reserves is on Southeast Asia and Russia.[48] [49]

Growing Chinese energy demand, coupled with its entrance into the World Trade Organization (WTO) in 2001, has accelerated foreign investment in China's crude petroleum sector, aimed at increasing domestic supplies. For domestic onshore crude petroleum, China opened exploration and development to joint ventures involving foreign firms in 1995. Foreign companies were permitted to operate only in specific regions approved by the State Council in conjunction with CNPC. When China entered the WTO in December 2001, crude petroleum tariffs dropped to zero, and 10 percent of the crude petroleum sector was opened up to competition. Foreign petroleum companies are now allowed to sell crude petroleum to Chinese refineries and large companies, bypassing state-run companies.[50] However, all foreign investments within China that produce crude petroleum are required to be joint ventures with state-owned Chinese companies.

CNPC, Sinopec, and CNOOC each successfully carried out initial public offerings (IPOs) between 2000 and 2002. In early 2000, CNPC formed a subsidiary, PetroChina, and sold a minority share of the company on both the New York and Hong Kong stock exchanges. BP was the largest purchaser, gaining 20 percent of the offered shares. Sinopec raised $3.5 billion from its IPO in October 2000, with most shares purchased by ExxonMobil, BP, and Shell. Shell bought the largest block of shares in CNOOC, which offered a minority of shares in a February 2001 IPO. However, the Chinese government still holds a majority interest in the three largest petroleum and gas firms, and foreign investors have not received any seats on the firms' Boards of Directors.[51]

Sixteen international petroleum companies have production activities in China, including ConocoPhillips, ChevronTexaco, and Shell.[52] Ten foreign companies are licensed to operate in the East China Sea under production-sharing contracts with Chinese state-owned companies.[53] Production-sharing is used in the exploration, development and production, and enhancement of recovery phases.[54] China often uses foreign investment as a means to access the technology and the capital it needs to develop the country's natural resources. CNPC, Sinopec, and CNOOC are the 3 national petroleum companies approved to manage production-sharing contracts with foreign businesses (table 2-3).

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[45] "China's CNPC, India's ONG."
[46] "Opportunity NOCs," 21-22.
[47] Ibid.
[48] Perez, *Who Wins.*
[49] In June 2005, CNOOC launched an $18.5 billion cash bid for the U.S.-based Unocal Corp. rivaling the bid from U.S.-based ChevronTexaco by more than $1 billion. As a result, of CNOOC's bid, the U.S. House of Representatives voted 398 to 15 against the proposed deal, calling it a risk to the U.S. national security. In August 2005, CNOOC dropped its bid and Unocal was taken over by ChevronTexaco.
[50] Office of Fossil Energy, *An Energy Overview.*
[51] Ibid.
[52] "Bohai Bay Bonanza," 14.
[53] PennWell Corp., *International Petroleum Encyclopedia,* 154.
[54] "Chinese Wells," 16-17.

Table 2-3 Foreign investment in Chinese crude petroleum assets: Selected joint ventures with CNOOC, 2002–2005

Foreign Company	Chinese Company	Location	Crude Petroleum Yield (barrels/day)
Conoco-Phillips (U.S.)	CNOOC	Bohai Bay	19,000
Kerr-McGee (U.S.)	CNOOC and Sino-American Energy (U.S.-Chinese joint venture)	Bohai Bay	45,000
ConocoPhillips (U.S.) and Shell (Netherlands)	CNOOC	South China Sea	11,000

Sources: "Bohai Bay Bonanza," 14; and Energy Information Administration, *China.*

Prior to China's entry into the WTO, it allowed only 4 state-owned operations to import crude petroleum.[55] Applications from private Chinese businesses to import petroleum began to be accepted in December 2001.[56] In February 2005, China liberalized regulations on private investment in the domestic petroleum sector. Foreign investment in China is required to take the form of joint ventures, and foreign investment in a company is limited to less than 50 percent of total equity.[57] Foreign investors also may not be represented on the companies' Boards of Directors.

China's accession to the WTO brought many changes within China's petroleum market, including the elimination of tariffs on crude petroleum and the further opening of the market to foreign investment. China has also signed various bilateral and multilateral agreements during the past 5 years as a means to ensure its access to crude petroleum supplies. These agreements allow for Chinese offshore exploration and help to ensure its supply of imported crude petroleum (table 2-4).

[55] These companies are China National Chemical Import and Export Co., China International United Petroleum and Chemicals Co., China National United Oil Co., and Zhuhai Zhenrong Co. PennWell Corp., *International Petroleum Encyclopedia,* 149.

[56] PennWell Corp., *International Petroleum Encyclopedia,* 149.

[57] Office of Fossil Energy, *An Energy Overview.*

Table 2-4 Selected international agreements associated with China's crude petroleum sector

Type of Agreement	Date	Countries Involved	Details of Agreement
Bilateral offshore exploration agreements	December 2000	Vietnam	The agreement determined the boundary of each country's economic area in the Gulf of Tonkin, opening the way for crude petroleum and natural gas exploration in that area.
	November 2002	Association of Southeast Asian Nations (ASEAN)	Joint Declaration on the Conduct of the Parties, which pledged to "undertake to resolve their territorial and jurisdictional disputes by peaceful means" without "resorting to the threat or use of force." This declaration aims to allow ASEAN members to devise a method of determining which parts of the seas belong to which member countries.
	March 2005	Philippines and Vietnam	Joint accord on marine seismic activities in the Spratly Islands.
Bilateral agreements to ensure import supply	January 2004	Venezuela	Trade and petroleum-supply agreements
	May 2005	Uzbekistan	Joint exploration agreement
	June 2005	Russia	Chinese company CNPC signed a long-term agreement with Russia's state-owned OAO Rosneft to increase exports of Russian crude petroleum to China. As a result, Russian exports of crude petroleum to China are expected to increase by 5 million metric tons in 2006, to 9 million metric tons.
	July 2005	Iran and India	The Shanghai Cooperation Organization (SCO), an intergovernmental organization formed by China, Russia, Kazakhstan, Kyrgystan, Tajikistan and Uzbekistan, has tabled a proposal to run a pipeline from Iran to India and possibly extend it to the Chinese border.

Source: U.S. Department of Energy, Energy Information Administration, *South China Sea Region September 2003*; Central Intelligence Agency, "China"; Zweig and Jianhai, "China's Global Hunt for Energy," 29; Watkins, "Russia, China Sign Energy Agreements"; and Bustelo, "China and the Geopolitics of Oil," 22.

China's Supply in Global Context

The long-term supply of crude petroleum is dependent on the successful exploration, development, and production of economically or commercially viable on- or offshore fields. Organization of Petroleum Export Countries (OPEC)[58] member countries are expected to continue to be the world's dominant suppliers of crude petroleum, accounting for 60 percent of the projected increase in world crude petroleum production capacity through 2025.[59] Several OPEC members have undertaken or have planned substantial investments to expand

[58] Member countries of OPEC are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.

[59] Energy Information Administration, *International Energy Outlook 2005*, 3.

production to ensure future crude petroleum supplies.[60] Increases in non-OPEC crude petroleum production are also expected in Russia, the North Sea, the Caspian Basin, Western Africa, and Central and South America.[61]

OPEC holds the largest share of global crude petroleum production. In 1995, OPEC members Saudi Arabia, Iran, Venezuela, Nigeria, and the United Arab Emirates (UAE) together accounted for more than 30 percent of the total market share of crude petroleum, although most of these countries experienced a modest decline in total market shares between 1995 and 2004 (table 2-5). While Saudi Arabia remains the world's largest producer, Russia has overtaken the United States as the second-largest crude petroleum producer in the world. China's market share changed little between 1995 and 2004, and averaged slightly less than 5 percent of total production over the period.

Table 2-5 World crude petroleum production and market shares, by major sources: 1995, 1999, and 2004[1]

Country	1995		1999		2004	
	1,000 b/d	percent	1,000 b/d	percent	1,000 b/d	percent
Saudi Arabia	8,231	13.2	7,833	11.9	9,176	12.7
Russia	5,995	9.8	6,079	9.2	8,856	12.3
United States	6,560	10.8	5,881	8.9	5,539	7.7
Iran	3,643	6.0	3,557	5.4	3,829	5.3
China	2,990	4.9	3,195	4.9	3,508	4.9
Mexico	2,618	4.3	2,906	4.4	3,405	4.7
Norway	2,768	4.5	3,018	4.6	2,786	3.9
Venezuela	2,750	4.5	2,826	4.3	2,657	3.7
Nigeria	1,993	3.3	2,130	3.2	2,483	3.4
United Arab Emirates	2,230	3.7	2,169	3.3	2,470	3.4
All other countries	22,557	36.2	26,253	39.9	27,558	38.1
World Total	62,335	100.0	65,848	100.0	72,266	100.0

Source: Energy Information Administration, International Energy Annual 2003; *BP Statistical Review, 2005*.

[1] 2004 production data and corresponding market shares are derived from 2003-2004 growth rates as published in BP Statistical Review, 2005.

[60] For a description of OPEC upstream investment plans by country, see "OPEC Upstream Investment Plans for 2005–2010," at http://www.opec.org/home/PowerPoint/Supply%20and%20Capacity/OPECUpInvestplan.htm. For a description of downstream investment plans by country, see "OPEC Downstream Expansion Plans 2005–2012," at http://www.opec.org/home/PowerPoint/Downstream%20Constraints/OPECDownstreamexpplans.htm

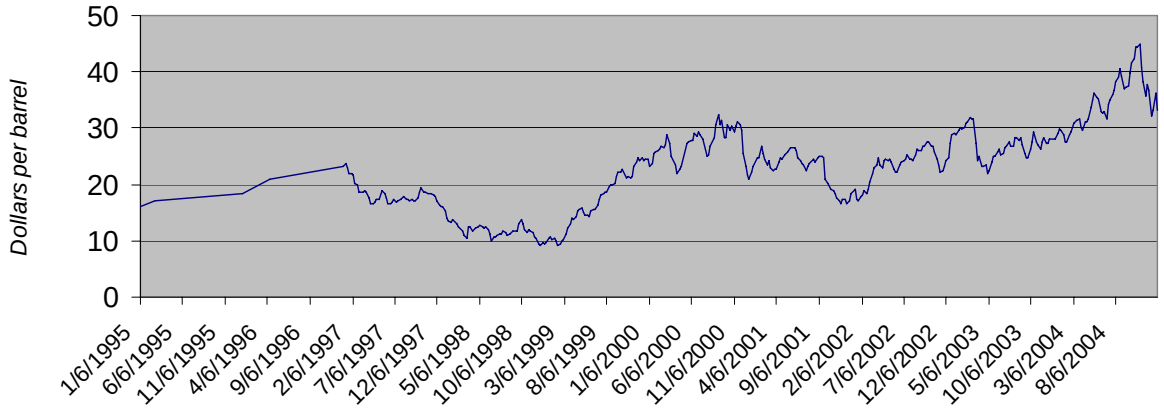
[61] Energy Information Administration, *International Energy Outlook 2005*, 3.

Price Trends

Crude petroleum prices have been highly volatile at times over the past 25 years, and periods of price volatility can be expected in the future principally because of unforeseen political and economic circumstances (figure 2-1). The price fluctuations reflect increased Saudi Arabian production during 1997-98, as well as supply disruptions during 1999-2004 (e.g., civil and labor unrest in Nigeria and Venezuela, and the war in Iraq).[62]

During this period, the average world crude petroleum spot prices, based on the benchmark crudes West Texas Intermediate and Saudi Light, roughly tripled; spot prices for China's Daqing crude also increased and were slightly higher than the benchmarks as China exported crude petroleum for hard currency (figure 2-2). During late 2005 and January-April 2006, crude petroleum prices topped $65 per barrel as a result of several factors including continued tight supplies on the world market, reductions in spare production capacity, labor unrest in Venezuela and Nigeria, and the war in Iraq. More recently, during late April 2006, prices have skyrocketed over $70 per barrel because of fears of a confrontation with Iran over its nuclear program (a major crude exporter), which has resulted in a significant geopolitical risk premium to the price of crude petroleum. Iran has been at the forefront in recent weeks due to its disagreement with the West over its nuclear program.

Figure 2-1 World crude petroleum spot price FOB weighted by export volume: 1995-2004

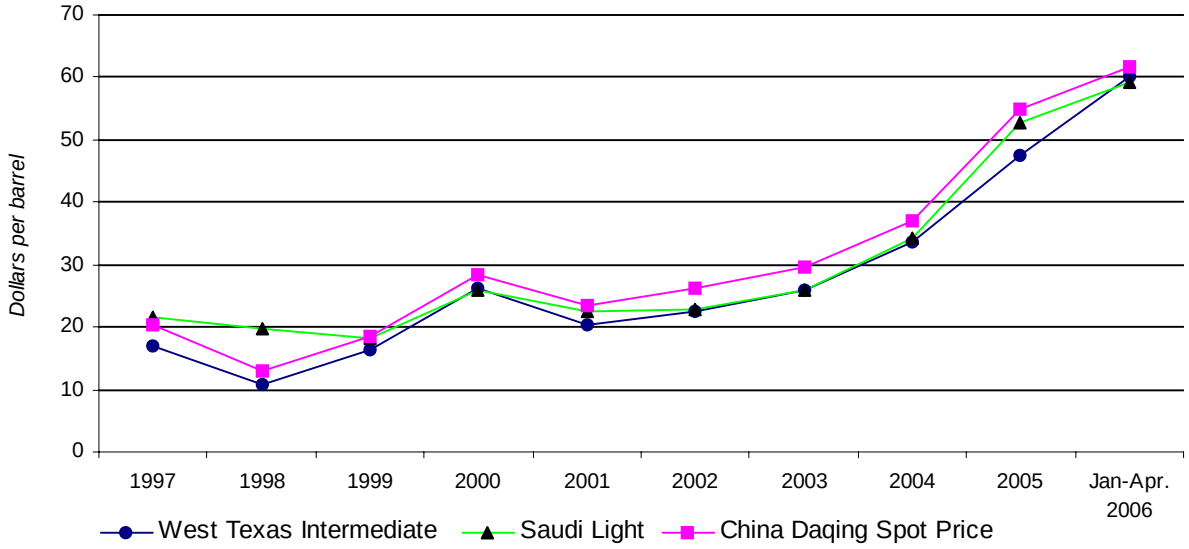


Source: U.S. Department of Energy, Energy Information Administration.

Note: Data for 1995 collected by the Energy Information Administration are for January 6 and February 24, 1995. Data for 1996 are from January 5 and April 12, 1995. Beginning in January 1997, world crude petroleum prices as published by the Energy Information Administration are collected on a weekly basis.

[62] Generally, crude petroleum is sold based on spot market prices. Supply contracts always contain clauses relating to the delivery price determined when a contract is signed. Such a clause is usually a fixed or base price escalated according to a given formula that corresponds to increases and/or decreases in the spot market price for benchmark crudes. The primary benchmark prices used worldwide for crudes sold out of New York or Rotterdam are based on West Texas Intermediate (WTI) crude, which is a sweet, light crude petroleum and is the premier crude type; Brent, which refers to crude that is not as sweet or light as WTI but still a high-grade crude priced about $1 to $2 less than WTI; and OPEC basket, which is a heavier, sour crude. In addition to each type, a benchmark price can be a combination of these primary benchmarks.

Figure 2-2 Crude petroleum: Average spot price for West Texas Intermediate, Saudi Light, and China Daqing, FOB weighted by export volume: 1995–2005 and January–April 2006



Source: Official statistics of the U.S. Department of Energy.

In general, crude petroleum prices will likely continue to be impacted by short term factors including tensions in the Middle East and labor unrest in major producing countries, and long-term factors including increased demand by emerging economies including China and India, and continued high demand for crude petroleum from the world's dominant consumer, the United States. Continued high crude petroleum prices could act to deter consumption and encourage the emergence of significant new petroleum and non-petroleum energy sources. Limits to long-term price escalation include substitution of other fuels (such as natural gas), marginal sources of conventional oil that become reserves (i.e., economically viable sources) when prices rise, and nonconventional sources of crude (such as oil shales) that become reserves at still higher prices. Advances in exploration and production technologies are also likely to bring prices down when such additional resources become part of the reserve base.

Recent economic studies suggest that, if all other factors were held constant, the increase in China's demand for crude petroleum during 1995-2004 was large enough to cause an increase in global prices. The price elasticities of supply estimated in the literature suggest that increases in China's demand alone (as measured by changes in Chinese consumption) would have raised global prices of crude petroleum by 12 percent to 37 percent between 1995 and 2004. Using the same assumptions, China's projected demand would result in an additional increase in global prices of anywhere from 4 percent to 20 percent by 2010. These estimates, however, do not take into consideration the supply increases that have taken place in the last ten years, or those projected to take place over the next five years, that might mitigate or eliminate these demand effects.[63]

[63] For further detail, see the appendix.

Trade Trends

Global trade of crude petroleum increased by almost one-third between 1995 and 2004,[64] a reflection of increased production and consumption of crude petroleum and petroleum products. OPEC and Middle East region producers[65] remained the most significant source of supplies. The United States has remained heavily reliant on OPEC and Middle East sources (table 2-6), while the European Union and China, in contrast, have diversified import sources. U.S. imports of crude petroleum increased by approximately 45 percent from 1995 to 2004. In contrast, China became a net importer of crude petroleum in 1993, with the Middle East overtaking the Asia-Pacific region as the principal supplier of crude petroleum to China.[66]

Between 1995 and 2004, Chinese imports of crude petroleum increased more than six-fold. The Middle East remains an important source of crude petroleum for China. On a volume basis, China's imports from the Middle East more than quadrupled between 1996 and 2004; however, the Middle East's market share in China has remained unchanged (figure 2-3).[67] Africa figures among China's fastest growing import sources of crude petroleum, increasing from 8.5 percent of China's total imports in 1995 to nearly 29 percent in 2004. China's interest in diversifying its sources of crude petroleum is evident in the geographic distribution of China's top import sources by country and volume imported in 2004 (table 2-7).

[64] American Petroleum Institute, *Basic Petroleum Data Book: Petroleum Industry Statistics* XXV, no. 2 (August 2005): section IX, table 9.

[65] Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, and Yemen.

[66] International Energy Agency, *China's Worldwide Quest*, 50. IEA notes that the Asia-Pacific region remains a principal source for refined petroleum products due to China's shortage of refinery capacity relative to domestic demand.

[67] Global Trade Atlas, China import statistics for HTS subheading 2709.00.

Table 2-6 Top U.S. general import sources of crude petroleum, by country and volume: 1995, 1999, and 2004

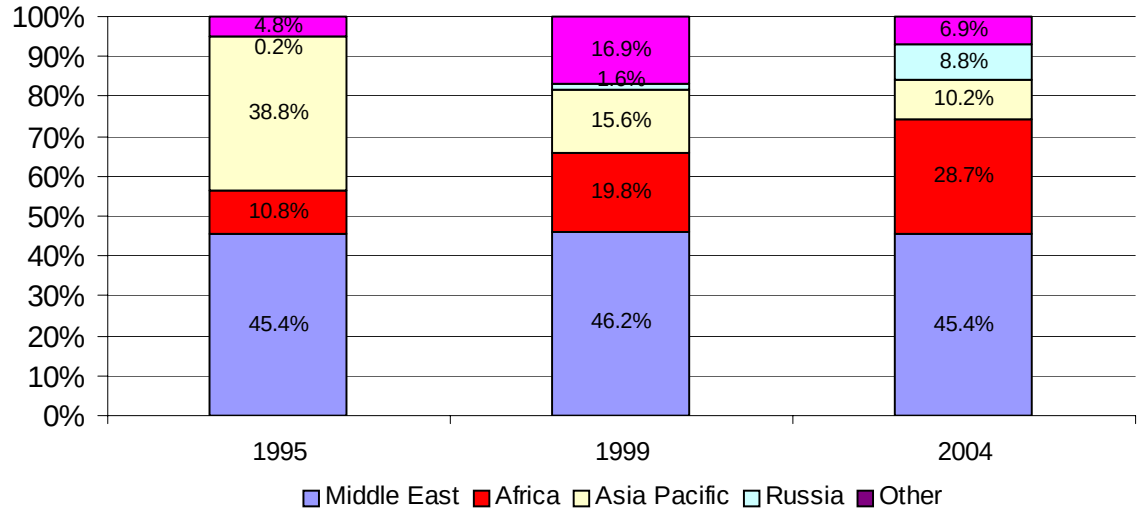
Partner Country	1995		1999		2004	
	1,000 Barrels	Percent	1,000 Barrels	Percent	1,000 Barrels	Percent
Canada	379,399	14.0	424,008	13.2	581,272	14.8
Venezuela	424,716	15.7	461,115	14.3	577,140	14.7
Mexico	345,710	12.8	447,781	13.9	566,600	14.4
Saudi Arabia	474,251	17.5	489,511	15.2	552,005	14.0
Nigeria	264,037	9.8	230,595	7.2	393,785	10.0
Iraq	([1])	([1])	263,399	8.2	247,079	6.3
Algeria	8,628	0.3	7,059	0.2	123,323	3.1
Angola	130,062	4.8	141,289	4.4	116,943	3.0
United Kingdom	140,991	5.2	99,551	3.1	98,884	2.5
Norway	91,070	3.4	111,445	3.5	91,886	2.3
Other	445,403	16.5	548,003	17.0	580,473	14.8
Total	2,704,267	100	3,223,755	100	3,929,391	100

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

Note: U.S. general imports are measured as the total physical arrivals of merchandise from foreign countries, whether such merchandise enters consumption channels immediately or is entered into bonded warehouses or Foreign Trade Zones under Customs custody. U.S. general imports include U.S. imports for consumption.

[1] No imports reported.

Figure 2-3 Geographic distribution of Chinese imports of crude petroleum by region: 1995, 1999, and 2004



Source: *Global Trade Atlas.*

Table 2-7 Volume, market shares, and rank for China's top import sources of crude petroleum: 1995 and 2004

Partner country	1995			2004		
	Import Volume (1,000 Barrels)	Market Share (Percent)	Rank	Import Volume (1,000 Barrels)	Market Share (Percent)	Rank
Saudi Arabia	2,481	2.0	6	126,401	14.0	1
Oman	26,777	21.4	1	119,829	13.3	2
Angola	7,321	5.8	3	118,806	13.2	3
Iran	6,825	5.4	4	97,030	10.8	4
Russia	267	0.2	7	78,992	8.8	5
Sudan	([1])	0.0	9	42,297	4.7	6
Vietnam	5,578	4.5	5	39,202	4.4	7
Yemen	18,128	14.5	2	36,006	4.0	8
Congo	187	0.1	8	34,988	3.9	9
Equatorial Guinea	([1])	0.0	10	25,543	2.8	10
Total	125,269	100.0		900,237	100.0	

Source: *Global Trade Atlas*.

[1] None reported.

China's dependence on imported crude petroleum is expected to increase from 45 percent of total domestic demand in 2004 to 80 percent by 2030.[68] In response, as discussed above, China is working to rapidly develop its domestic supplies and further secure international petroleum sources.[69] The Chinese government established its State Energy Office in 2004, which is tasked with lowering China's petroleum import dependence. To that end, the Chinese government has implemented policies limiting crude petroleum exports by state-owned companies.[70]

[68] This import reliance figure differs slightly among sources. For example, the World Energy Outlook 2004 forecast Chinese petroleum import dependence to be 75 percent in 2030. Energy Information Administration, *China*; "Chinese Wells," 16-17; Logan, *Annual Energy Outlook for 2005*; and Office of Fossil Energy, *An Energy Overview.*

[69] International Energy Agency, *China's Worldwide Quest.*

[70] International Energy Agency, *Oil Market Report*.

CHAPTER 3
Unwrought Aluminum

Summary of Conclusions

While Chinese demand for unwrought aluminum has had an impact on global prices, the magnitude of the price effect is not clear. Increased global demand, rising input costs, production declines in the United States and Europe, along with significant consolidation and restructuring of leading market participants have also contributed to the increased global price for aluminum. However, China's role in the aluminum marketplace is not insignificant. Increased Chinese demand and production have contributed to higher input costs for aluminum smelting worldwide, industry restructuring and consolidation, and changes in global trade flows for unwrought aluminum.

China's impact on the global market has been significant in three principal ways. First, China's need for alumina[1] to fuel its expanding aluminum production has driven alumina prices to record highs, narrowing profit margins for producers of unwrought aluminum and contributing to restructuring throughout the industry. Second, anticipation of growth in China's demand for aluminum has increased production capacity worldwide. New countries have emerged as leading players in world markets as firms look to streamline operations and take advantage of low-cost electric power. Finally, China's role in the global marketplace has expanded significantly as state-owned Aluminum Corporation of China (Chalco) has emerged as one of the world's leading aluminum producers and China has moved from a net importer of aluminum to a net exporter.

Looking forward, it is uncertain whether Chinese aluminum output can keep pace with anticipated growth in domestic consumption from its rapidly urbanizing economy and expanding industrial production. Despite having abundant bauxite deposits, China will continue to rely on imported alumina, due to insufficient refining capacity and the low quality of Chinese bauxite. Such imports will likely be increasingly sourced from Chinese investments in bauxite and alumina projects located abroad. Future prospects for growth in China's production of unwrought aluminum depend on progress in addressing high-cost and inadequate supplies of alumina and electric power, upgrading outdated smelting technologies, and complying with potentially strict government measures to rein in production overcapacity in the aluminum industry.

Demand issues

Factors Broadly Affecting Demand

The principal end uses for aluminum are the transportation, packaging, and construction markets.[2] Global demand for unwrought aluminum has been robust since 2002, as the U.S. economy recovered from the 2001 recession and as airlines recovered from the adverse

[1] Alumina is the primary material input to unwrought aluminum. Alumina is refined from bauxite ore.
[2] The Aluminum Association.

impacts of the September 11 terrorist attacks on passenger air travel. Demand growth is especially evident in the transportation sector, which accounts for approximately one-third of worldwide aluminum consumption. A major driver has been the shift from iron castings to aluminum castings for automotive components[3] and increased demand from the aerospace industry, a major consumer of sheet and plate. Aluminum's light weight is ideal for automobile manufacturers seeking to reduce vehicle weight to improve fuel efficiency and reduce emissions.[4] Accordingly, the aluminum content in passenger vehicles and light trucks has grown more than 40 percent and 68 percent, respectively, since 1991.[5] In the aerospace market, increased build rates for both military and civil aircraft have led to increased demand for aluminum.[6] For example, between 1995 and 2004, U.S. production increased from 1,625 to 3,440 aircraft per year, despite a significant drop-off in production after the September 11 attacks.[7] A new surge of aircraft orders in 2005 should sustain aerospace industry demand for aluminum through 2008.[8]

In the construction market, leading uses of aluminum are for window frames, doors, and facades, closely followed by support framing for roofs and walls.[9] The construction market has been particularly strong in the United States, Russia and industrializing economies, especially China and India.[10] Housing starts in the United States for privately owned units grew by 34 percent between 1994 to 2004.[11]

Demand for aluminum packaging, consisting mostly of flat-rolled aluminum sheet for beverage cans and foils for food packaging, also grew strongly from 1994 through 2004. During the period, many new applications for aluminum beverage cans were introduced, particularly for energy drinks and beer.[12] Additionally, the packaging market reflected increasing trends for prepared meals and blister-packaging for pharmaceutical products.[13]

Demand for Aluminum in China

Chinese demand, as measured by Chinese consumption of unwrought aluminum, grew almost every year during the 1995-2004 period, nearly doubling between 1995 and 1999, and subsequently more than doubling between 1999 and 2004. Over the full 10-year period, Chinese consumption rose nearly three-fold (up 4.0 million metric tons) to reach 5.9 million metric tons by 2004, equal to 20.1 percent of global consumption in that year.

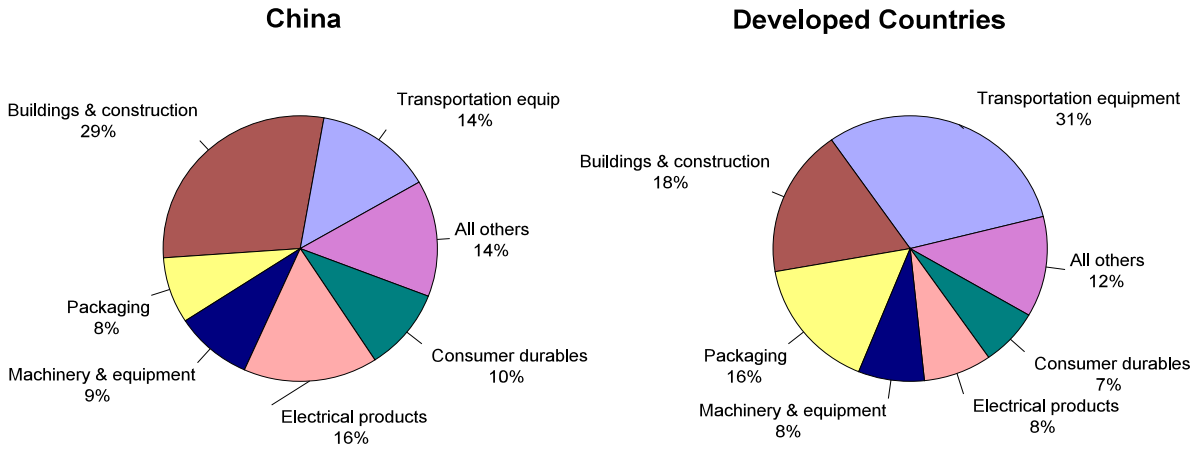
In contrast to developed countries where the transportation sector dominates, building and construction is the largest aluminum consuming sector in China (figure 3-1), a reflection of ongoing building construction and infrastructure development and significantly lower per-

[3] "Alcan Forecasts Growth of Auto Business."
[4] Stutovich, "Counter Intelligence: Engine Parts."
[5] Larkin.
[6] Pinkham, "Demand for Aircraft Aluminum Reaches New Levels."
[7] *U.S. Aircraft Production–Civil, Aerospace, Fact & Figures 2005-2006*, 28.
[8] Anselmo, Velocci Jr., Wall, and Mecham, "Supply and Demand," and Pinkham,"Demand for Aircraft Aluminum Reaches New Levels."
[9] "Aluminum Applications and Society– Construction,"
[10] Kassakovich, "Future is Bright as Aluminum Demand is Set to Soar," 28-29.
[11] Compiled from official statistics of the U.S. Census Bureau.
[12] "Aluminum Bottles Rival Popularity of Plastic."
[13] "Recent Developments Reviewed in European Rolling Sector."

capita automobile ownership.[14] In addition, the share of Chinese aluminum consumption accounted for by electrical products and consumer durables exceeds that of many industrialized nations, a reflection of both the country's growing export-oriented manufacturing sector and its rising domestic consumer markets.

China's relatively low per-capita consumption rate for unwrought aluminum, coupled with its expanding industrial activity and government housing programs, suggest that Chinese demand for aluminum will continue to grow, particularly in the construction and automotive sectors.[15] An estimated 3.3 million apartments are being built every year in China, averaging approximately 240 million square meters of new housing each year.[16] Further, as discussed in chapter 4, Chinese builders and home buyers do not use wood frame construction, increasing builders' demand for aluminum compared to equivalent new housing construction in other markets. Moreover, major construction projects for the 2008 Olympics will also commence shortly.[17] Finally, ownership of private automobiles in China is expected to increase. According to the Central Government, vehicle sales in China may rise to 9.4 million units in 2010 (from 5.1 million in 2004). By 2010, Chinese aluminum usage in automobiles is anticipated to approach 2.5 million metric tons.[18]

Figure 3-1 Consumption shares of aluminum in all forms, by end-use consuming sectors, 2004



Source: Evans, 15.

[14] In 2003, there were only 16.2 automobiles per 1,000 persons in China, compared to 800 automobiles per 1,000 persons in the United States, and 600 automobiles per 1,000 persons across all developed countries. Hunt Jr., "The China Factor, Aluminum Industry Impact."

[15] Evans, 13; and *Aluminum in China, Industry Profile*, DataMonitor, and "Aluminum Demand Soars."

[16] Leung and Czachorski, "The Global Competitiveness– a Perspective View of a Chinese Extruder."

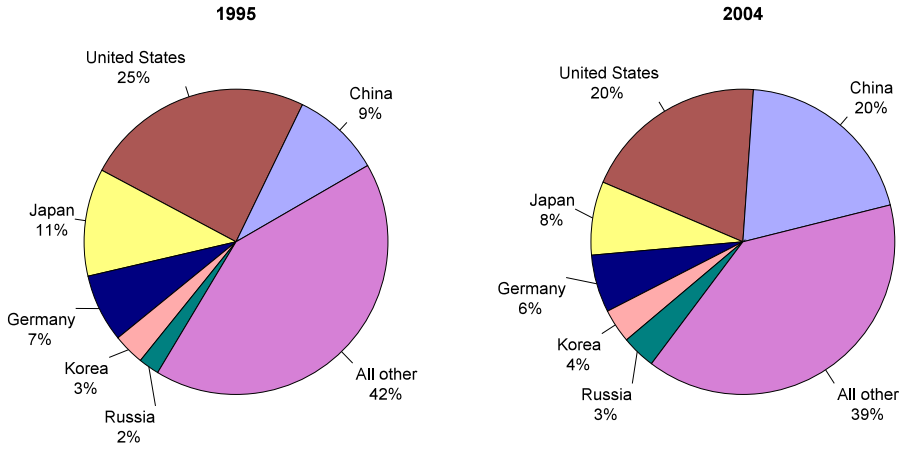
[17] "From Accelerator to Brake, the Chinese Economy has Driven a Boom in Commodity Markets, It May Be Turning Into a Drag."

[18] "Aluminum Demand Soars."

China's Demand in Global Context

Between 1995 and 2004, China's strong demand growth was a key factor in increased global consumption, accounting for almost 45 percent of this increase. China's share of global consumption expanded significantly, from 9.4 percent to 20.1 percent (figure 3-2). In fact, China surpassed the United States in 2004 as the world's leading consumer of aluminum. Worldwide consumption of unwrought aluminum grew steadily from 1995 through 2004,[19] increasing 44 percent to 29.5 million metric tons, largely resulting from increased demand from the transportation, packaging, and construction markets, particularly in the latter half of the period.

Figure 3-2 Unwrought primary aluminum: Consumption by country



Source: World Bureau of Metal Statistics, "Aluminum World Refined Consumption," World Metal Statistics, various months.

Supply issues

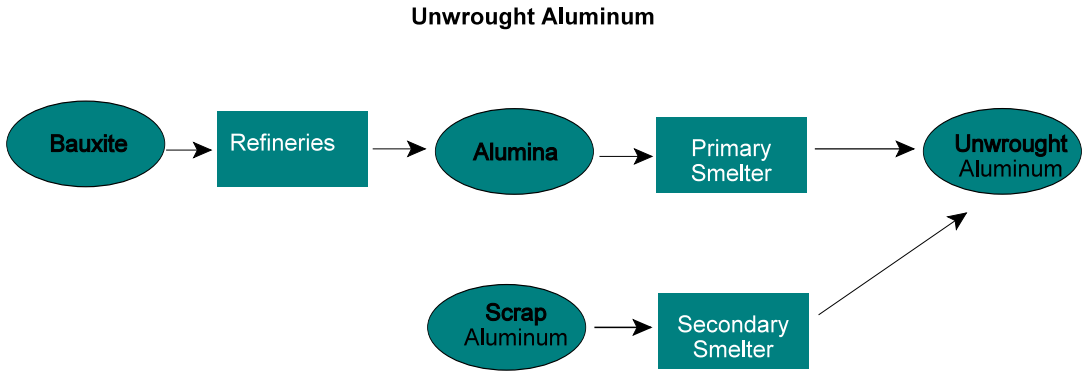
Factors Broadly Affecting Supply

The global supply of unwrought aluminum is constrained by the complicated process by which aluminum is produced and the high costs associated with this process. While aluminum is the most abundant metallic element in the earth's crust, it does not occur

[19] In 2004, China consumed 20.1 percent of unwrought aluminum compared to 19.6 percent for the United States.

naturally in a metallic state. Therefore, a majority of unwrought aluminum is produced through a two-step process (figure 3-3).[20] First, ***bauxite***, an aluminum bearing ore, is refined into ***alumina***, a white powder of aluminum oxide. Then, ***alumina*** is converted into ***aluminum*** in a smelting process. Two to three tons of bauxite are required to produce one ton of alumina and two tons of alumina are required to produce one ton of aluminum metal.

Figure 3-3 Aluminum manufacturing process



Aluminum smelting is very expensive due to the high capital costs associated with building and maintaining a smelter and high input costs, primarily for electricity and alumina. The average industry business operating cost in 2004 was $1,124/ton of unwrought aluminum. Input costs have escalated in recent years, particularly for energy (29 percent of input costs in 2004) and alumina (38 percent). Energy costs, particularly in the United States, have increased significantly and these rising costs have affected the viability of many smelters. Further complicating the production process is that most aluminum smelters are not located in proximity to producers of alumina. Bauxite tends to be found in sub-tropical areas principally in developing countries, including Brazil, Jamaica, and Suriname. Leading smelting countries, such as the United States, import all the alumina necessary to produce unwrought aluminum. In recent years, alumina has become more commoditized, and it can be bought and sold on the spot market.[21] In the past 5 years, alumina prices have risen significantly, driven by Chinese import demand, as its alumina refineries lack the capacity to meet its smelter needs.[22]

A final component of supply is the availability of aluminum produced from secondary sources in the marketplace. Secondary aluminum metal can be recovered by melting down recycled aluminum scrap in a process that is significantly less expensive than smelting alumina into aluminum. Because of this cost savings, many aluminum producers have expanded their involvement in this type of secondary smelting. However, unwrought

[20] A small percent of unwrought aluminum is produced by secondary smelters that melt down recycled aluminum scrap.
[21] Forty-five percent of the global alumina supply is traded. "Alumina Prices: What Should We Expect?"
[22] "Aluminum Production– a Chinese Puzzle."

aluminum produced from secondary smelters currently represents a small share of the global unwrought aluminum supply.

Supply of Aluminum in China

China has played a central role in the changing global supply of aluminum. Annual production of aluminum in China increased at an average annual rate of 12.4 percent during 1995-2001, accelerating to 25.0 percent during 2001-2004 (table 3-1). In 2001, China surpassed the United States, Russia, and Canada to become the world's top producer of unwrought aluminum. China has continued to increase its production level each successive year, accounting for 22.1 percent of total production in 2004. As noted above, another component of supply is secondary recovery from scrap.[23] Currently, China generates about 21 percent of its unwrought aluminum from remelted scrap, 55 percent of which must be imported.[24]

Table 3-1 China: Mine production of bauxite; production of alumina; and production of unwrought aluminum, and primary capacity of unwrought aluminum, 1995-2005 (1,000 metric tons)

	Bauxite	Alumina	Unwrought aluminum	Capacity
2005e	17,000	([1])	8,000	9,250
2004e	15,000	6,990	7,470	8,260
2003	12,500	6,140	5,970	5,700
2002	12,000	5,450	4,510	5,300
2001	9,500	4,650	3,500	4,250
2000	9,000	4,330	2,990	2,640
1999	8,500	3,840	2,810	2,640
1998	8,200	3,330	2,440	2,580
1997	8,000	2,940	2,180	2,380
1996	6,200	2,550	1,900	1,750
1995	5,000	2,200	1,870	([1])

Source: Plunkert; and Tse, "The Mineral Industry of China."

"e" estimated.
[1] Not available.

Despite strong production growth in recent years, the Chinese aluminum industry faces considerable constraints. In the short term, the high market price of alumina has increased production costs for aluminum. In 2005, 40 percent of the country's smelters were operating at a loss and an estimated one-quarter of Chinese capacity was idle.[25] Additionally, the Chinese aluminum industry's rapid expansion risks overwhelming the world market, leading to sharp declines in the global market price for unwrought aluminum.

In the longer term, inadequate electricity supply and the lack of high-quality bauxite constrain further expansion of Chinese aluminum production. For example, inadequate and uncertain electric power supplies have prevented expansions of several primary smelting

[23] Yu and Yuan, "Alliance is Forged to Cut Alumina Prices.; and "Chinese Aluminum Companies Form Alliance to Negotiate Prices."
[24] Foster, "Self Sufficiency Still a Ways Off for China Aluminum Scrap."
[25] Teo, "NDRC, Up to a Quarter of China's Aluminum Smelting Capacity Idle."

operations.[26] Additionally, China currently relies on imports for an estimated one-half of the alumina necessary to meet its aluminum smelting needs, as the mineral content of the Chinese bauxite renders it more expensive and difficult to refine than bauxite available elsewhere.[27] The only major supplier of alumina from domestic sources in China is Chalco, which has traditionally supplied many Chinese aluminum smelters with alumina through contracts priced below the cost of imports. Imported alumina usually reflects the spot market price. However, as Chalco has expanded its production of domestic unwrought aluminum, the firm has reduced sales of alumina in order to supply its own smelters and has raised the price at which it sells alumina to other firms. Chalco's action, along with increased production of aluminum worldwide, has increased market demand for alumina, causing worldwide prices for alumina to rise significantly.

In accord with China's Industrial Development Policy (IDP), Chinese government agencies imposed a variety of measures in recent years to limit demand for alumina, reduce exports of unwrought aluminum, and forestall potential smelter overcapacity.[28] However, due to the numerous agencies involved, there is no comprehensive Chinese government policy toward the aluminum industry and at times the varying measures seem at cross purposes. Policies implemented to streamline the industry by eliminating small, inefficient smelters have actually stimulated expansion of modern, large-scale smelters.[29] Industry response to the government measures has been mixed, and legislation reportedly has accomplished little to slow the ongoing expansion of the Chinese aluminum industry.[30]

The most significant new government measures aimed at reducing aluminum smelter expansions have curbed bank loans and halted construction of new production facilities in the aluminum smelting sector.[31] NDRC initiated further constraints against apparent overcapacity by withholding land approvals and bank loans for aluminum smelters. Additionally, measures such as minimum production thresholds and industry entrance standards were instituted for 2006. Most significant, recent regulations require that new smelter projects be located in regions with adequate power supplies. However, projects utilizing advanced technologies that meet energy, resource utilization, and environmental standards will still be encouraged.[32]
Unwrought aluminum producers reportedly have agreed to form an alliance to cut output by delaying new capacity startups, but it is unclear whether this will have any significant effects.[33] No time frame was provided for these cutbacks and details of the agreement were

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[26] Sanmenxia Tianyuan Aluminum Group Co. Ltd. (Henen), Lanzhou Aluminum Co. (Lianhai, Gansu Province), and Alcoa-Chalco (Beijing) delayed smelting expansions in 2003 due to power supply problems. Wong, "Asian Juggernaut Looks to Gently Cool Down Growth Engine."

[27] "Aluminum Demand Soars."

[28] Wong, "Asian Juggernaut Looks to Gently Cool Down Growth Engine." Key government agencies involved in the alumina and aluminum sectors in China include the National Development and Reform Commission (NDRC), the State Development and Reform Commission (SDRC), Ministry of Commerce (MOC), the General Administration of Customs (GAC), and the Ministry of Finance and State Administration of Taxation.

[29] Pratt, 14.

[30] "Aluminum Production, a Chinese Puzzle," 8.

[31] Wong, "Asian Juggernaut Looks to Gently Cool Down Growth Engine," and "China Imposes New Guidelines on Investments."

[32] According to Liu Zhi, head of the NDRC's Industry Policy Bureau, "blind" investments have caused overcapacity in the aluminum sector, and new electrolytic smelting projects need to be restricted and phased out as they are resource intensive, energy intensive, and environmentally unfriendly. Teo, "China Bans More Projects in Wider Crackdown on Metals,"and "China Readies New Aluminum, Copper Rules."

[33] All 20 smelters currently holding alumina import licenses, and another 3 that do not, were represented at the meeting. Teo, "Doubts Surface Over Plan to Cut China Aluminum Output."

not revealed.[34] Market participants have expressed doubts as to whether the majority of aluminum producers will follow through with their agreed cuts to output given currently strong domestic aluminum prices.[35] Further, to avoid recent government controls imposed on smelting in China, Chinese and Hong Kong entities have also begun to seek foreign direct investment opportunities for developing aluminum smelters abroad (table 3-2).

Table 3-2 Chinese outbound foreign direct investment to secure unwrought aluminum resources

Investor	Target (country)	Month/ year	Details
Henan Hong Kong Longquan Aluminum Trading Co. Ltd.	Gebeng aluminum smelter (Malaysia)	May 2005	Henan and the Pahang State Development Corp. are the partners that requested approval from the Malaysian Industrial Development Authority to construct an aluminum smelter in Gebeng, Pahang State, Malaysia.[1]
Luneng Group Ltd. Co.; and Sinohydro Corp.	Sarawak aluminum smelter (Malaysia)	May 2005	Cahya Mata Sarawak Bhd (CMS) reached an agreement with Luneng Group and Sinohydro Corp. to jointly investigate the feasibility of constructing and operating an aluminum smelter in Sarawak State, Malaysia. This project was approved in late 2005, and in early 2006; the partners reportedly proposed to Malaysian authorities to double the smelter's capacity to 2 million metric tons per year.[2]
Chinese and Hong Kong investors	Manjung aluminum smelter (Malaysia)	July 2003	An investor consortium is to develop an 820,000 metric tons per year aluminum smelter project in the Manjung district. The project is anticipated to be completed in 2006, pending approval by the Malaysia Department of the Environment.[3]

[1] "Pahang Seeks Approval for Aluminum Project."
[2] "CMS and Chinese Sign MoU," and "Cahya Mata and Partners May Double Capacity at Proposed Al Smelter."
[3] "Malaysia Smelter Plans Gather Pace."

Measures have also been taken to try to slow the aluminum industry's expansion by managing alumina imports, particularly for those smelters that are export oriented. For example, in 2004, China's Ministry of Commerce (MOC) and the General Administration of Customs (GAC) announced an immediate prohibition on imports of alumina by smelters with capacity below 100,000 metric tons per year that export unwrought aluminum. Also introduced were more stringent controls on official approvals of permits for construction of new smelters that intend to import alumina and export aluminum.[36] Finally, aluminum smelters and trading firms are required to possess a permit for importing alumina, with only 20 firms holding such permits, including Chalco.[37]

Further, Chinese aluminum entities are increasingly looking abroad for additional supplies of alumina in order to meet demand at home (table 3-3). The Chinese Government has

[34] Ibid.
[35] Shanghai-based metals analyst, cited in Teo, "Doubts Surface Over Plan to Cut China Aluminum Output."
[36] No new permits were to be forthcoming for firms that currently rely on the outdated Solderberg smelting technology or on low-current (less than 160 kA) prebake smelting technology.
[37] Teo, "China Planning to Trim Alumina Import Tax."

Table 3-3 Chinese outbound foreign direct investment to secure alumina resources

Investor	Target (country)	Date	Details
China Minmetals Corp. (Minmetals)	Bauxite mine and alumina refinery (Jamaica)	July 2005	Minmetals reached agreement with the Jamaican Government to proceed with the next phase of feasibility studies for developing a bauxite mine and a 1.4 million metric tons per year alumina refinery, now that the due diligence studies and site visits have been completed.[1]
Chinese Aluminum Group (CAG)	Boke alumina refinery (Guinea)	May 2005	CAG signed an offtake agreement, in May 2005, with Global Alumina Ltd. that plans to construct an alumina refinery in the Boke region of Guinea. CAG will receive long-term purchase rights to 25 percent of the output from the 2.8 million metric tons per year refinery and the possibility of purchasing a stake in Global.[2]
Minmetals	Sherwin Alumina Co. (U.S.)	April 2004	Minmetals acquired the second-largest North American alumina refinery and requested that the management of Sherwin consider boosting the refinery's annual capacity from the current 1.6 million metric tons level. Sherwin has supply contracts with Minmetals, dating back to January 2004, and with several other Chinese customers. Sherwin sent initial major alumina shipments to China in late February-early March 2004. Sherwin will supply about 35 percent of its output under contract to Chinese customers.[3]
Aluminum Corp. of China (Chalco)	Dac Nong bauxite mine and alumina refinery (Vietnam)	December 2005	A joint venture concluded with the Vietnam Coal Group (Vinacoal) for the joint development of the Dac Nong bauxite mining and alumina refining project. The current plan is for the alumina refinery to be developed in two phases, with an initial 1.9 million metric tons per year capacity, rising to 4.0 million metric tons per year in the latter phase. The feasibility study for this project is currently underway and it is too early to announce Chalco's anticipated stake or when production would commence.[4]
Chalco	Alumina do Norte do Brasil (Alunorte) alumina refinery (Brazil)		Chalco reportedly discussed with Companhia Vale do Rio Doce (CVRD), in February 2004, the possibility of assuming a stake in the Alunorte alumina refinery. Chalco could partake in the currently approved and ongoing expansion of Alunorte's annual capacity from the current 2.4 million metric tons to 4.2 million metric tons. CVRD may also acquire in a minority share of a Chalco aluminum smelter in China.[5]

[1] U.S. Department of State, and "China Said Eyeing Jamaican Alumina Refinery."

[2] "Guinea Ratifies Global Alumina Project," and Brooks, "Chinese Group, Global Alumina Ink Offtake Pact."

[3] Brooks, "Minmetals Asks Sherwin to Hike Alumina Output," and "Sherwin Gearing Up for China Alumina Shipments," and "China Metals Company Buys Equity Interest in Sherwin Alumina," and Compiled from Zephyr Mergers and Acquisitions database, Zephus Ltd., Bureau van Dijk Electronic Publishing.

[4] "Chalco Signs MOU for Joint Development of Vietnam Alumina Project." and "Alumina Project at Dac Nong of Vietnam to be Approved." and "Chalco Signs MoU for Vietnam Bauxite and Alumina Project."

[5] Kinch, "Chinese Committed to Brazil Refinery Project," and "Expansion of Alunorte Plant is Near, Brazilian Miner Says" and "Producers Hot, Analysts Not On Brazilian Alumina Project,; "China Gives Backing to CVRD Alumina JV," *Metal Bulletin*, January 18, 2006.

encouraged exploration and development of natural resources abroad by Chinese entities. In addition, the NDRC and the Import & Export Bank of China are providing credit support for investment projects in both domestic and offshore natural resources projects. The Chinese Aluminum Group (CAG), formed in 2003 as an international alumina sourcing consortium consisting of Minmetals, Chalco, and a group of integrated coal-electricity-aluminum producers,[38] are actively developing bauxite deposits around the world.[39] Chinese aluminum producers are also seeking foreign joint-venture partners as sources for securing steady supplies of alumina from abroad.

Finally, the Chinese Government has significantly reduced aluminum-related import tariffs, including those for alumina and aluminum (table 3-4), beyond those required by China's WTO Accession Agreement. Beginning on January 1, 2006, import tariffs were further reduced from 8 percent to 5.5 percent on alumina and were eliminated for aluminum scrap. Additionally, tax rebates previously enjoyed by exporters of aluminum and aluminum-containing products were eliminated and the MOC officially imposed new export taxes of 5 percent on unwrought aluminum.[40]

Table 3-4 Alumina, unwrought aluminum, and scrap aluminum: Import duty and export rebate/tax rates, 2001-05, percent

Item	2001	2002	2003	2004	2005
Import tariffs:					
Alumina	18	12	10	8	8
Unwrought aluminum	9	5	5	5	5
Scrap aluminum	6	1.5	1.5	1.5	1.5
Export tax rebate or (tax):					
Unwrought aluminum	15	15	15	8	-5

Source: Evans, 22.

China's Supply in Global Context

Growing demand and higher aluminum prices have encouraged expansion of aluminum smelting capacity worldwide, particularly from 1999 through 2004, when global production increased by 6.1 million metric tons. China accounted for over 65 percent of this production increase, whereas U.S. production decreased significantly, declining from 15.9 percent to 8.4 percent of global production over this 5-year period. The U.S. decline illustrates the shift in production from traditional producing regions, such as the United States and Western Europe, to producing countries and regions with lower electric-power costs, such as Iceland, the Middle East, Russia, and Brazil.

Additionally, there has been a significant change in the makeup of the industry. Formerly leading producers, such as Kaiser, have withdrawn from the market and many firms have consolidated in order to streamline their facilities for greater operating efficiency (e.g., the mergers of Alcan with Algroup, Alcoa with Reynolds, and Alcan with Pechiney). As the traditional producers leave the market or consolidate, significant new producers have

[38] "Guinea Ratifies Global Alumina Project."

[39] Chen, "China Aluminum Group Calls for Policy Changes."

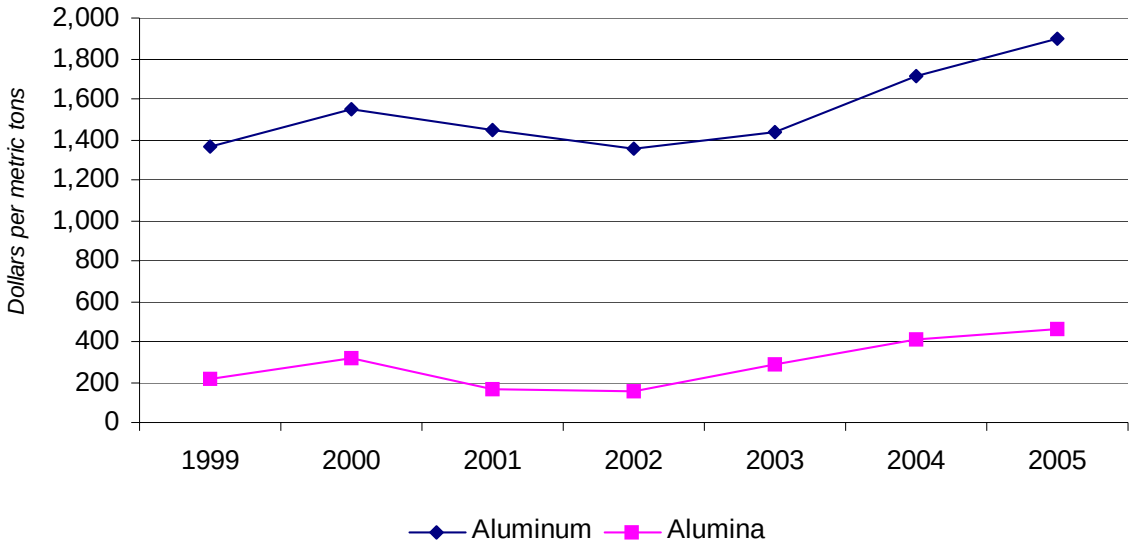
[40] "China Set to Cut Export Tax Rebates, U.S. Thrust for Stronger Yuan," and McCulloch, "China Set to Abolish Export Tax Rebates January 1.

emerged onto the global aluminum market from Brazil (CVRD), Russia (e.g., Rusal and SUAL) and China (Chinalco/Chalco).

Price Trends

Aluminum prices have remained robust over the past several years, reaching $2,377 per metric ton in January 2006, a 48-percent gain over January 2004 and more than double the March 1999 low of $1,182 per metric ton (figure 3-4). During the same period, alumina prices also increased significantly, reaching $590 per metric ton by the end of 2005, more than 4 times the low of $135 per metric ton in November of 2001.

Figure 3-4 Aluminum, nonalloyed, high grade: London Metals Exchange monthly average spot prices, 1999-2005



Source: Compiled from daily statistics of the London Metals.

However, it is difficult to isolate the effect of China's increased demand on the global price of aluminum. Price elasticities of supply estimated in the economic literature suggest that increases in China's demand (as measured by changes in Chinese consumption) should have increased global prices of unwrought aluminum by 8 percent to 52 percent during the period 1995 to 2004 and may be expected to cause a further increase of between 6 percent and 36 percent by 2010. However, these estimates do not account for large increases in the supply of unwrought aluminum, especially from China, and changes in demand from other countries. In fact, when considering only unwrought aluminum, the impact on the global prices of growth in both Chinese consumption and production taken together is not clear. It is clear, however, that higher Chinese demand for alumina and aluminum scrap caused prices for these inputs to increase, which in turn caused aluminum prices to increase, thus affecting downstream consumers worldwide.[41]

[41] For further detail, see the appendix.

Trade Trends

The value of global unwrought aluminum trade increased 59.3 percent to $17.8 billion between 1999 and 2004,[42] reflecting growing consumption, shifting geographic locations among the major producers, and the increase in world prices. The European Union (EU-25) remained the largest importer of unwrought aluminum, followed by Japan, the United States, and Korea. During 1999-2004, EU-25 imports increased by 56.0 percent, and U.S. imports rose 68.5 percent, as domestic production declined due to high electric power costs (figure 3-5).

Worldwide exports of unwrought aluminum grew in value by 44.1 percent during 1999 to 2004, to reach $14.3 billion (figure 3-6).[43] Export values dipped during 2001-02 before growing rapidly in 2003 (by 11.8 percent) and 2004 (by 23.6 percent) as a result of higher aluminum prices. U.S. exports of aluminum decreased by $41.9 million (21.6 percent) during the 5-year period, slowing most significantly during 2001-03, as escalating electricity prices forced smelters to shut down, particularly in the Pacific Northwest.

In contrast, Chinese exports of unwrought aluminum increased by $2.2 billion during 1999-2004 as domestic production surpassed consumption, allowing China to become a net exporter of unwrought aluminum beginning in 2002 (figure 3-7). The extent to which China remains a net exporter of unwrought aluminum depends on resolving a number of conditions that will constrain the domestic smelting industry for the foreseeable future, discussed in more detail above. These include continued government restrictions on capacity expansions,[44] adequate and stable supplies of alumina, and the availability of electric power at reasonable rates. According to some aluminum industry observers, industry-constraining forces and rising domestic consumption are anticipated to slow Chinese aluminum exports over the next one-three years.[45]

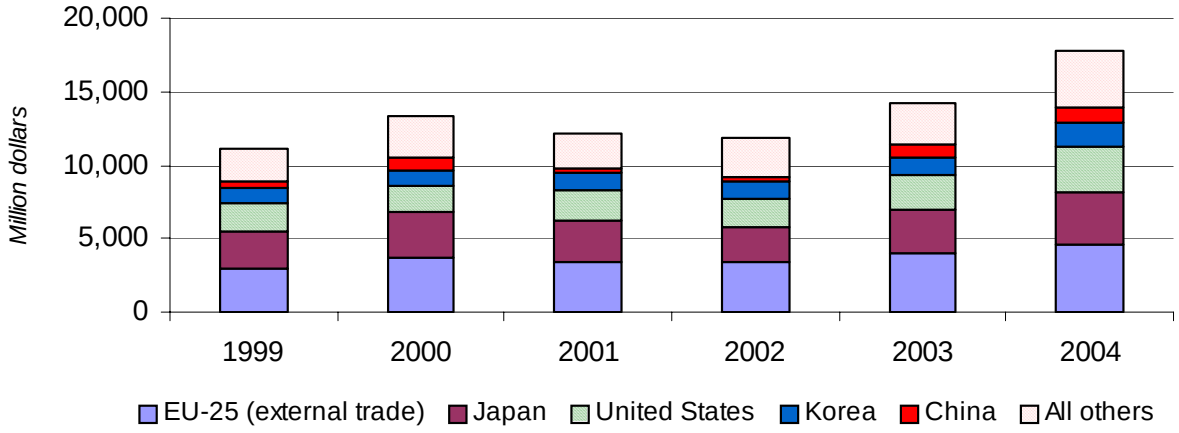
[42] Global aluminum trade is presented in value terms in figures 3-4 and 3-5, rather than in less-complete quantity terms across all reporting countries, as available from Global Trade Information Services.

[43] Data may exclude some developing countries, as not all report aluminum trade data.

[44] Forster, "Aluminum Demand to Remain Strong; Global Supply Tight: BHP," 14.

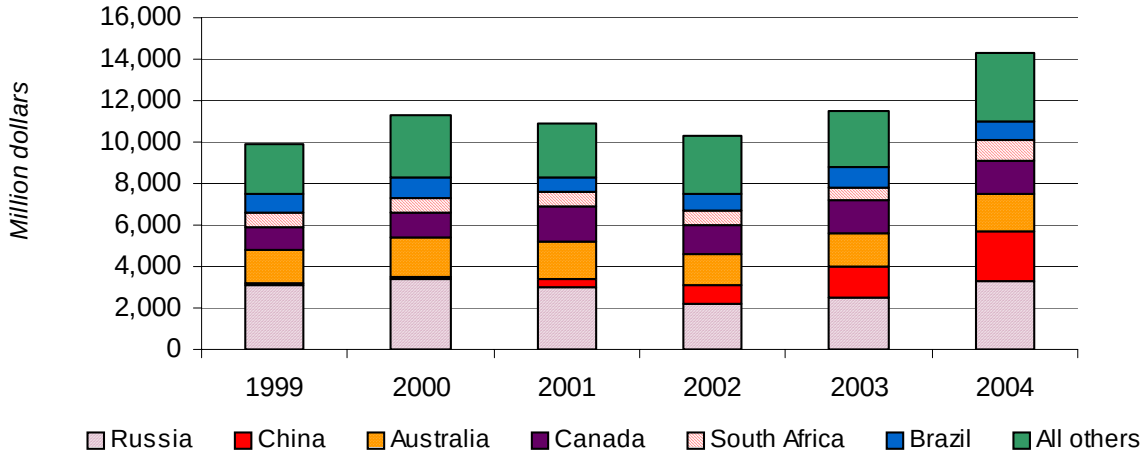
[45] See e.g., Evans, "Primary Aluminum, the China Syndrome," 38.

Figure 3-5 Unwrought aluminum: Imports from all sources,by importer, 1999-2004



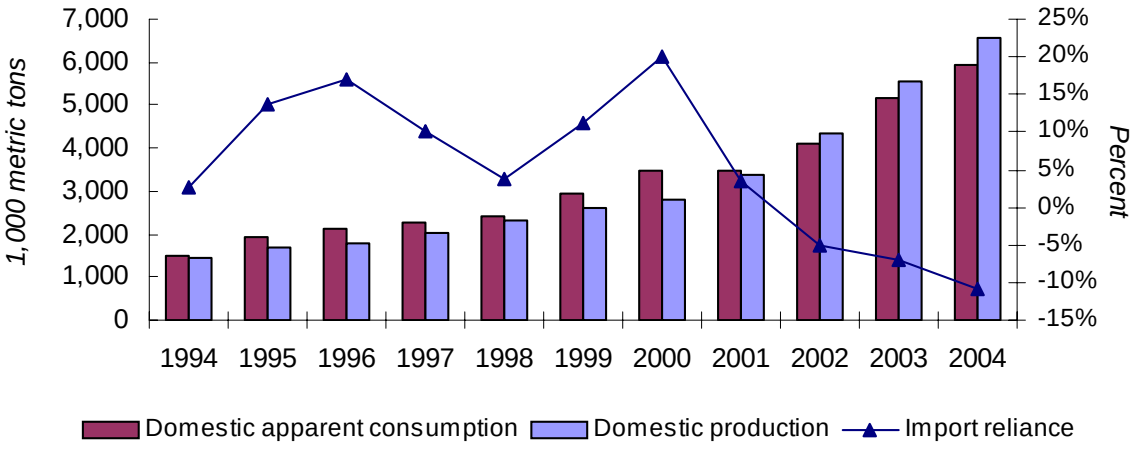
Source: Compiled from statistics of Global Trade Information Service.

Figure 3-6 Unwrought aluminum: Exports to all destinations, by exporter, 1999-2004



Source: Compiled from statistics of Global Trade Information. Service.

Figure 3-7 Unwrought aluminum: Chinese domestic apparent consumption, domestic production, and net import reliance, 1994-2004



Source: World Bureau of Metal Statistics, World Metal Statistics, various months.

CHAPTER 4
FOREST PRODUCTS[1]

Summary of Conclusions

The rapid expansion of China's paper and wood processing industries has required a steady increase of imports of forest products input materials due to China's limited domestic forest resources. This demand significantly changed the pattern of global forest products trade between 1995 and 2004. The scarcity of domestic forest resources makes China an unlikely country to become a large producer of forest products. China has invested heavily in domestic paper manufacturing capacity despite the fact that it is not a labor intensive industry and the fact that Chinese mills may not have reliable, low cost supplies of wood fiber. The extent to which China's aggressive investment will suppress investment in other countries and perhaps even short-circuit the recent shift in pulp and paper production towards countries with greater domestic forest resources is not yet fully appreciated. As its paper and wood processing industries continue to expand, China's imports are expected to shift from intermediate products such as paper and lumber to raw materials such as wood pulp, waste paper, and logs. Expanding port facilities in North America and logistics improvements in the interior of China will continue to encourage the westbound transpacific flow of forest products from North America to Asia.

Despite steep increases in Chinese demand, global prices for various forest products showed no clear upward trend or only small increases between 1995 and 2004. Global market prices for wood pulp, waste paper, and hardwood lumber were constrained by 1) plentiful supplies of forest resources, including some quantity of illegally harvested logs, 2) ample additions to global capacity, and 3) low or moderate increases in consumption in other countries. However, price increases for hardwood products are expected in the future as a result of on-going international efforts to curb illegal logging.[2] The full impact of strong Chinese demand on global waste paper prices has been mitigated by capacity closures and generally weak demand in the United States and Europe.[3] A more probable result than increased global prices for raw materials will be weak global prices for a variety of finished paper and wood products and/or capacity closures in other countries.

[1] Most Chinese imports of forest products are classified under Harmonized Tariff Schedule (HTS) headings 4403, 4407, 4703, 4707, 4804, 4805, 4810, and 4811. The impact of Chinese demand on these products will be discussed in the context of the two major sectors of the forest products industry, pulp and paper and wood products.

[2] "North American Hardwood Exports," 7.

[3] "Recovered Paper: China Casts a Wide Supply Net."

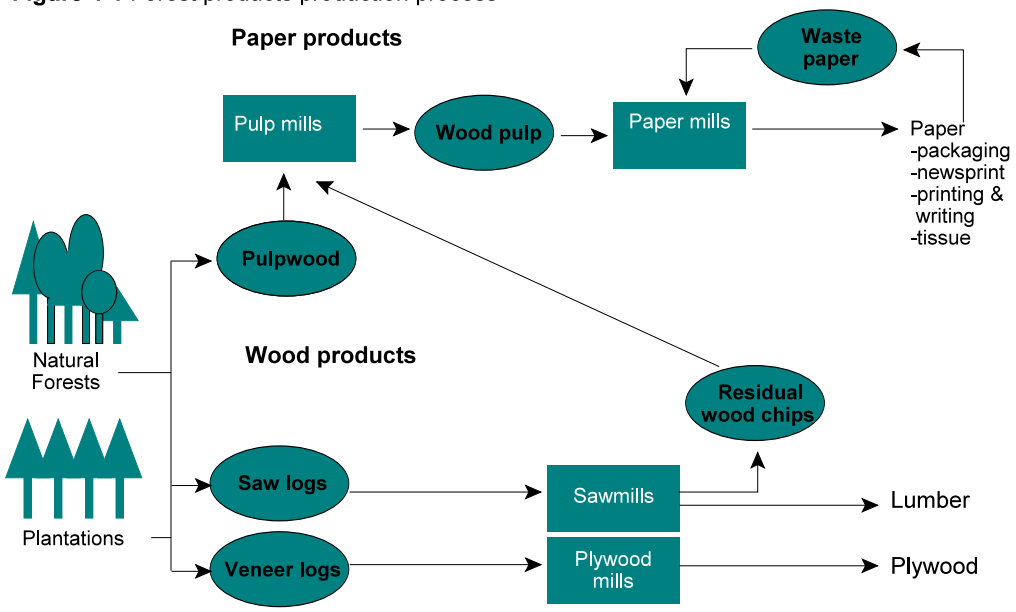
Pulp and Paper

Demand

Factors broadly affecting demand

Major end uses for paper include packaging, newsprint, printing and writing papers, and tissue products. The consumption of paper products is driven by economic activity. As a result, per capita consumption in developed countries is generally higher than in developing countries.[4] In turn, the demand for paper drives demand for wood pulp and for waste paper, the primary raw material inputs for paper (figure 4-1). The increasing importance of waste paper as a source of wood fiber between 1995 and 2004 is reflected in the small annual increase in worldwide consumption of wood pulp (table 4-1) and the much larger increase in consumption of waste paper (table 4-2). It is unlikely that global waste paper recovery and consumption will continue to expand as rapidly as in the past because collection costs and fiber quality will become more important issues as recovery rates rise.

Figure 4-1 Forest products production process



[4] On a regional basis in 2004, per capita consumption in North America (303 kg), Australasia (157 kg), and Europe (131 kg) was above the world average (56 kg). Consumption in Latin America (38 kg), Asia (34 kg), and Africa (7 kg) was below average. The United States consumed 312 kg per capita, and China consumed 41.6 kg per capita. In comparison, Taiwan consumed 226.6 kg, and Hong Kong consumed 159.9 kg per capita in 2004. 2005 Annual Review.

Table 4-1 Wood pulp: Top five countries ranked by consumption and global market share, 1995 and 2004

	Consumption		Global Market Share		Average Annual Growth Rate
	1995	2004	1995	2004	1995–2004
Country	1,000 metric tons		Percent		
United States	58,263	53,530	33.7	28.5	-0.9
China	14,625	21,483	8.5	11.4	4.4
Canada	15,784	15,852	9.1	8.4	0.0
Japan	14,633	13,039	8.5	6.9	-1.3
Finland	8,894	10,432	5.2	5.6	1.8
World	172,641	187,766	100.0	100.0	0.9

Source: Pulp & Paper International 2005, *Annual Review*.

Table 4-2 Waste paper: Top five countries ranked by waste paper recovery and consumption, 1995 and 2004

	Recovery			Consumption		
	1995	2004	Average Annual Growth Rate	1995	2004	Average Annual Growth Rate
Country	1,000 metric tons		1995-2004	1,000 metric tons		1995–2004
United States	39,305	43,818	1.2	30,338	31,758	0.5
Japan	15,473	21,507	3.7	15,687	18,753	2.0
China	8,246	16,513	8.0	9,136	28,812	13.6
Germany	10,531	13,219	2.6	8,599	12,169	3.9
United Kingdom	3,981	6,582	5.7	4,013	5,172	2.9
World	115,061	170,473	4.5	115,395	174,494	4.7

Source: Pulp & Paper International 2005, *Annual Review*.

Demand for pulp and paper in China

Chinese consumption of paper products is likely to continue to be fueled by China's further development of its economy, the expansion of its printing and publishing industries, and a rapid growth in spending for advertising.[5] Although per capita usage almost doubled, China's consumption in 2004 was only 13.3 percent of per capita consumption in the United States. Thus, there is still a large potential demand in China, and industry forecasts project that annual consumption of paper in China will reach 80 million to 93 million metric tons by 2015.[6]

Transportation costs are a significant factor affecting the growth of Chinese imports of relatively low-value forest products from North America. In transpacific trade, freight rates assessed for westbound U.S. exports are roughly one half of those for eastbound U.S. imports.[7] This imbalance exists because the total volume of U.S. merchandise imports from Asia is roughly twice the volume of U.S. exports to Asia,[8] resulting in a surfeit of shipping containers in the United States and substantial excess vessel capacity on westbound voyages.[9] Attractive backhaul rates are offered by logistics providers to encourage U.S. shippers to use containers that would otherwise return to China empty. An official of Chinese shipping firm COSCO noted that waste paper alone accounted for almost 33 percent of the firm's westbound transpacific trade, three times the tonnage of the next largest commodity, scrap metal.[10] It is unlikely that the fundamental rate structure of the transpacific trade will change in the near future. In fact, the expansion of container handling facilities at ports in Western Canada is expected to increase opportunities for North American shippers to take advantage of backhauls to Asia.[11]

The United States remained the largest market for pulp and paper, using over one quarter of all paper consumed in 2004. Four of the top five countries (the United States, Japan, Germany, and the United Kingdom) have highly developed economies and mature paper markets. These countries' rates of growth in consumption were positive but lower than that of global consumption causing their share of the global market to decline between 1995 and 2004.

Despite its relatively low per capita consumption, the size of China's economy has made it a leading paper consumer and the fastest growing market for paper. Between 1995 and 2004, China's per capita annual consumption of paper increased from 21.7 kg to 41.6 kg. Consumption of paper in China grew at an average annual rate of 8.3 percent compared with a global increase of 3.0 percent, and China overtook Japan as the second largest consumer

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[5] "China Charges Ahead in Printing and Writing Papers," *Solutions*, vol. 89, no. 1 (January 2006), 54.

[6] One forecast suggested that China's consumption of paper would grow 5 percent annually until 2020. Jim Kenny, "The World Looks Just a Little Brighter in 2006," *Solutions* 89 (1), January 2006, 29, and "China Aims to Invest $48 Billion in the Paper Sector by 2015," found at http://www.paperloop.com and retrieved March 14, 2002.

[7] Eastbound freight for a 40-foot container is approximately $2,400 and for a westbound container approximately $1,200. Jean-Jacques, Ruest, "Opportunity to Capture China Boom New Logistics Opportunities."

[8] It is estimated that 2.65 loaded containers move from Asia to the United States for every loaded container moving westbound. "Industrial Inputs, Raw Materials Lead U.S. Export Growth to Asia," and Federal Maritime Commission, *43rd Annual Report for Fiscal Year 2004*, 38.

[9] Federal Maritime Commission, 43rd Annual Report for Fiscal Year 2004, 38.

[10] The official noted that waste paper was only marginally profitable and that the firm used waste paper as ballast. "China's Demand for Waste Paper Threatens North American Producers."

[11] Ruest, Jean-Jacques, "Opportunity to Capture "China Boom" New Logistics Opportunities."

of paper behind the United States (table 4-3). In absolute terms, China's increase in consumption accounted for one third of the global increase in consumption. A principal driver of China's increase in consumption was the need for paper packaging (e.g., corrugated boxes, folding cartons) to satisfy the demand of the expanding manufacturing sector, which in turn drove China's increasing demand for paper and its components, wood pulp and waste paper. Between 1995 and 2004, the combined value of Chinese imports of paper, wood pulp, and waste paper increased at an average annual rate of 15.5 percent (table 4-4).

Table 4-3 Paper: Top five countries ranked by consumption and global market share, 1995 and 2004

	Consumption		Global Market Share		Average Annual Growth Rate
	1995	2004	1995	2004	1995–2004
Country	1,000 metric tons		Percent		
United States	87,409	92,257	31.6	25.6	0.6
China	26,499	54,392	9.6	15.1	8.3
Japan	30,019	31,426	10.9	8.7	0.5
Germany	15,834	19,442	5.7	5.4	2.3
United Kingdom	11,288	12,678	4.1	3.5	1.3
World	276,231	359,904	100.0	100.0	3.0

Source: Pulp & Paper International 2005, *Annual Review*.

Table 4-4 Chinese forest products imports by segment, 1995–2004

Description	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
					(Millions of Dollars)					
Wood pulp and waste paper[1]	699	732	694	831	1,344	2,248	2,358	2,551	3,380	4,640
Logs and lumber[2]	517	638	946	945	1,908	2,634	2,681	3,294	3,639	4,178
Packaging and printing papers[3]	1,452	1,846	2,250	2,442	2,817	2,836	2,633	3,031	3,112	3,257
Other headings[4]	2,062	2,283	2,468	2,455	2,499	2,640	2,181	2,301	2,805	3,049
Total forest products	4,730	5,498	6,358	6,673	8,568	10,358	9,851	11,177	12,935	15,124
	Share of Total Chinese Forest Products Imports									
					(Percent)					
Wood pulp and waste paper[1]	15	13	11	12	16	22	24	23	26	31
Logs and lumber[2]	11	12	15	14	22	25	27	29	28	28
Packaging and printing papers[3]	31	34	35	37	33	27	27	27	24	22
Other headings[4]	44	42	39	37	29	25	22	21	22	20

Source: *World Trade Atlas*.

[1] Defined as all products classified in HTS headings 4703 and 4707.

[2] Defined as all products classified in HTS headings 4403 and 4407.

[3] Defined as all products classified in HTS headings 4804, 4805, 4810, and 4811.

[4] Defined as products classified in all remaining HTS headings in chapters 44, 47, and 48.

Supply

Factors broadly affecting supply

As a result of the relatively low value and high transportation costs of pulpwood and wood chips, the manufacture of pulp and paper has traditionally been undertaken in countries or regions of abundant forest resources[12] and is not, therefore, evenly distributed. Pulp and paper producing countries typically supplement harvests from natural forests by establishing tree plantations, but as supplies of wood from natural forests have become depleted or constrained by increased regulations, countries in warmer, moister regions with more favorable growing conditions and higher potential growth rates have gained a significant competitive advantage. Thus, the manufacture of pulp and paper has begun a slow migration away from well-developed industries in the Northern Hemisphere toward countries at lower latitudes and in the Southern Hemisphere such as Brazil, Chile, and Indonesia where tree plantations of various fast-growing, often exotic, species (e.g., *Eucalyptus, Acacia, Pinus*) have been established. Although these regions' natural advantage was long recognized, modern paper manufacturing operations generally require a well-developed economic and industrial infrastructure to support them. Therefore, the migration is taking place slowly, as countries have steadily expanded manufacturing capacity in step with their developing infrastructure and expanding plantations.

Supply of pulp and paper in China

For its size, China is not well-endowed with forest resources. On a per capita basis, China's 115 million hectares (284 million acres) of natural forests are small relative to many other countries. Many of its forests are in remote, mountainous regions, and years of over harvesting and/or land use conversion have depleted the remainder.[13] Its 53 million hectares (131 million acres) of plantations are unevenly distributed and of generally poor quality, and only 23 million hectares (57 million acres) are dedicated to forest production.[14] A national effort to restore China's forests culminated in 1998 with the National Forest Protection Program (NFPP), under which the State Forestry Bureau banned timber harvests on 95 million hectares in 17 provinces[15] and developed plans to increase imports of forest products.[16] Despite a reduction in the number of mills between 1995 and 2004, China's paper capacity expanded at an average annual rate of 12.8 percent, compared with a global capacity increase of 2.7 percent, as larger, more modern mills opened. Chinese pulp capacity expanded at an average annual rate of 5.1 percent, far faster than the global increase of 1.1 percent.

Between 1995 and 2004, China posted the highest growth rate in paper production, surpassing Japan to become the second largest producer. China's annual output of paper increased from 24.0 million to 49.5 million metric tons (table 4-6) and accounted for 31.2 percent of the annual increase in global production. Approximately 80 percent of the

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[12] U.S. International Trade Commission, *Conditions of Competition in U.S. Forest Products Trade*, xiv.

[13] Ibid., 5-42.

[14] Chinese plantation forestry began in 1971 and was emphasized in the 1990s after two major floods caused both ecological and economic disasters. As the impetus for developing plantations was ecological, use of wood fiber was not emphasized. Allen T. Y. Chan, "How Much Risk? Investment Strategies for China," and Tony Zhang, "China's Plantation Program: Will It Be Able to Supply the Growing Needs of Both Wood Products and Pulp and Paper Producers?"

[15] "China's Appetite for Timber Grows," 1, 4.

[16] Ibid.

new paper capacity has been built in four coastal provinces convenient to imported wood pulp and waste paper.[17] The increase during the period in China's annual production of pulp, 340,000 metric tons, was more modest due to limited domestic supplies of wood fiber.[18] Nevertheless, the Chinese Government plans to spend $24 billion during the next six years to fund new virgin fiber pulp mills.[19] Discarding the old policy of reliance on imported raw materials, the Government has stated its intention to become self-sufficient with respect to wood fiber. To that end, China intends to establish an additional 13.3 million hectares of tree plantations by 2015.[20] However, an industry analyst expects that production at the new pulp mills will continue to be limited due to the relatively slow development of Chinese plantations.[21]

Between 1995 and 2004, the Chinese government encouraged domestic papermaking capacity through loans to various companies.[22] Also, there have been many joint ventures between Chinese and foreign firms.[23] Nine Dragons, a large Chinese manufacturer of packaging papers, was approved for an IPO on the Hong Kong stock exchange in March, 2006.[24] However, one U.S. industry source recently alleged that Chinese investments have been made without proper due diligence or strategic planning and are motivated more by employment potential than profitability potential.[25] Recently, a Chinese industry source estimated that to continue to meet China's increasing demand for paper, an additional 40 million metric tons of capacity would be required by 2015 at a cost of $48 billion, at least part of which was expected to come from foreign sources.[26] In anticipation of further investments in paper making capacity, some pulp mills have been purposely constructed with more pulp capacity than initially necessary to facilitate the future addition of paper machines.[27]

Some new pulp and paper facilities in China are very large relative to existing mills. For instance, an Indonesian company, Asia Pulp and Paper (APP), recently constructed the world's largest single-line pulp mill on Hainan Island, China, with a planned annual capacity

[17] Robert G. Flynn, "China's Paper Industry: What Low-Cost Labor Advantage?"

[18] In 2005, Chinese fiber supply for paper was estimated to be 49 percent waste paper, 30 percent nonwood fibers, and 21 percent wood pulp. "China Charges Ahead in Printing and Writing Papers," 54.

[19] Although they may use some recycled fiber, virgin fiber mills are so-called because they depend primarily on pulpwood as a source of wood fiber. Rooks, Alan, "Dancing With the Dragon," 8.

[20] Zehui Jiang,"Current Situation and Future Perspective of Forest Products Development in China," and "Report from China," 12.

[21] "China Charges Ahead ," 54.

[22] Rooks, "Dancing with the Dragon," 8.

[23] By 1999, more than 100 joint venture or foreign-owned pulp and paper mill operations had already been started with firms from Asia, Europe, and North America. Three European paper companies, UPM Kymmene, Stora Enso, and Norske Skog,, have been particularly active in China. U.S. International Trade Commission, *Conditions of Competition in U.S. Forest Products Trade*, 5-47, and Kenny,"The World Looks Just a Little Brighter in 2006," 28.

[24] "Nine Dragons to Launch IPO in Hong Kong."

[25] Flynn, "China's Paper Industry."

[26] "China Aims to Invest $48 Billion in the Paper Sector by 2015."

[27] Rooks, "Jiangxi Chenming Drives Chinese LWC Market," 27.

of 1 million metric tons.[28] Two other firms have also announced plans for mills with capacities of 1 million metric tons. Indonesian-based Asia Pacific Resources International (APRIL) has announced plans for installation of a new million ton pulp line at its Rizhao mill. It is estimated that 200,000 hectares of plantations would be necessary to supply the mill with wood chips. Initially, APRIL intends to supply the mill with wood chips from its own Indonesian plantations and those of other timber firms in Indonesia.[29] Another million ton mill is being developed by Stora Enso in conjunction with the state-owned Gaofeng Forest Pulp & Paper Company. The integrated paper mill in Guangxi Province is expected to produce approximately 1 million tons of pulp and 1 million tons of paper annually.[30]

One industry executive recently predicted a dramatic increase in outbound Chinese foreign direct investments aimed primarily at securing long term supplies of raw materials, especially softwood fiber.[31] APRIL's plan to supply its Rizhao mill from the firm's Indonesian plantations appears to confirm the need for offshore fiber supplies.

Industry analysts also predict that the current wave of capacity expansion in China will have the most impact on the global markets for printing and writing paper and packaging paper. An estimated 3 million metric tons of new printing and writing paper capacity in China will cause a large ripple in global markets as the displaced current suppliers to Chinese customers seek new markets for their paper.[32] Also affecting printing and writing paper markets is the large growth of the printing industry in China, which has caused a drop in demand for book paper by printers in North America.[33] The continued decline in exports of both linerboard and boxboard to China is expected to have an adverse impact on the North American markets for packaging paper.[34]

As China shifts from net importer to net exporter of paper, Chinese mills are expected to favor domestic customers, which are more profitable for local suppliers, but are also expected to increase shipments to export markets, particularly the United States and Japan.[35] China recently announced the elimination of a rebate for the 13 percent VAT on exports of paper made from imported pulp. Most producers were granted exemptions for 2006, which will delay the impact until 2007, but the change is expected to reduce both Chinese exports and imports as domestic production is shifted to local customers.[36]

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[28] APP already has extensive operations in China and is planning further expansions despite continued legal maneuvers stemming from massive debt ($13 billion) accumulated from previous capacity expansions in Indonesia. The firm recently announced plans to increase production at the Hainan mill by 30 percent and to build a paper mill in Shanghai with an annual capacity of 2 million metric tons. Rooks, "Dancing With the Dragon," 8, "APP China Starts to Sell Hainan Plant's Pulp," "APP China Signs Up Aker Kvaerner for Upgrade at Hainan Mill," and "APP China Looks to Build Another New Mill."

[29] "APRIL Plans Massive Pulp Expansion in China."

[30] "Stora Enso Looks to Build Massive New Forest Products Complex in China."

[31] Rooks, "Will China's Monster Mills Wake Up the West?," 4.

[32] "Development in the China Paper Industry Set to Disrupt World Markets."

[33] Ibid.

[34] Ibid.

[35] "What is Projected for China's Printing and Writing Paper Trade," found at http://www.paperlopp.com and retrieved January 23, 2006.

[36] Ibid.

China's supply in global context

The United States and Canada, each with abundant forests and well-developed economies, rank high in production of both wood pulp and paper (tables 4-5 and 4-6). China and Japan also rank high in the production of pulp and paper but are more reliant on recycled paper as a raw material due to limited supplies of wood fiber from native forests. Between 1995 and 2004, the top five countries all increased paper production, and global production of paper increased more than three times faster (2.9 percent annually) than global pulp production (0.9 percent annually). Pulp production actually decreased in the United States and Japan, but the declines were offset by increased recoveries of waste paper (table 4-3).

Table 4-5 Wood pulp: Top five countries ranked by production, 1995 and 2004

	Production		Share of Global Production		Average Annual Growth Rate
	1995	2004	1995	2004	1995–2004
Country	1,000 Metric Tons		Percent		
United States	59,682	53,585	34.2	28.4	-1.2
Canada	25,388	26,406	14.6	14.0	0.4
China	13,840	14,180	7.9	7.5	0.3
Sweden	10,089	12,106	5.8	6.4	2.0
Japan	11,120	10,720	6.4	5.7	-0.4
World	174,275	188,496	100.0	100.0	0.9

Source: Pulp & Paper International 2005, *Annual Review*.

Table 4-6 Paper: Top five countries ranked by production, 1995 and 2004

	Production		Share of Global Production		Average Annual Growth Rate
	1995	2004	1995	2004	1995–2004
Country	1,000 Metric Tons		Percent		
United States	81,000	83,401	29.2	23.2	0.3
China	24,000	49,500	8.6	13.8	8.4
Japan	29,663	30,889	10.7	8.6	0.5
Canada	18,705	20,461	6.7	5.7	1.0
Germany	14,827	20,392	5.3	5.7	3.6
World	277,791	359,598	100.0	100.0	2.9

Source: Pulp & Paper International, *Annual Review*.

In step with increasing environmental awareness, global recovery of waste paper increased at an average annual rate of 4.5 percent during the period. Until the 1980s, the reuse of waste paper was confined to mills that produced relatively low quality tissue, paperboard, and/or industrial paper products.[37] Subsequent regulations mandating recycled content, voluntary recycling targets, and/or advances in papermaking technology have encouraged rapid growth in the use of waste paper. In the United States alone, approximately 240 mills consumed waste paper in 2000, over 60 percent of which used 100 percent recycled fiber. Despite their

[37] U.S. International Trade Commission *Industry & Trade Summary, Wood Pulp and Waste Paper*, 24.

large paper industries, the United States, Japan, Germany, and the United Kingdom generated waste paper in excess of their needs in 2004. Conversely, China's rapidly expanding industry consumed 12.3 million metric tons of waste paper more than domestic production.

Price Trends

Wood pulp flows freely in global markets and is generally subject to very low rates of duty. Historically, the market price of wood pulp has been highly volatile. Prices fluctuate as economies expand or contract, and the inelasticity of pulp supply,[38] shifts in inventory, and exchange rate fluctuations may amplify wood pulp pricing cycles.

Prices of northern bleached softwood kraft pulp (NBSK)[39] in the North American and Northern European markets fluctuated widely during the last decade, but despite minor timing discrepancies, prices in the markets track closely over time (figure 4-2). A large price increase followed the recession of the early 1990s, and inventories rose rapidly in 1995 as customers purchased in anticipation of further increases. Inventory liquidation in 1996 and soft seasonal demand for paper in Europe caused prices to plunge. After a rally in 1997, the Asian financial crisis and consequent soft Asian demand resulted in falling prices in 1998. Strong paper demand in 1999, low inventories, mill downtime/closures, and limited new capacity helped solidify the market. Prices peaked in 2000 before falling as the U.S. economy declined.[40] Declining inventories, strong U.S. demand for hardwood pulp, and strong Chinese demand for softwood pulp arrested the price decline in 2002.[41] Strong Asian demand continued in the first quarter of 2003,[42] and after a seasonal summer downturn, prices continued upward.

Despite cooling demand in Asia and Europe, price levels held in 2004 due to strong U.S. shipments of printing and writing papers.[43] Prices peaked in early 2005 before slipping due to soft seasonal demand, lower demand in China, and new capacity in China and Europe.[44]

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[38] Pulp mills are capital-intensive and tend to maintain production despite soft demand during economic downturns. Conversely, long lead times for new capacity constrain supply in the short-term, so strong demand may induce large price increases before new supply is available. Also, high prices may induce more capacity than is otherwise necessary, resulting in extended periods of oversupply and soft prices.

[39] As a preferred grade of wood pulp, NBSK serves as the benchmark of pulp pricing. Prices of other grades are determined as discounts from the price of NBSK.

[40] U.S. International Trade Commission, *Industry & Trade Summary, Wood Pulp and Waste Paper*, 18-19.

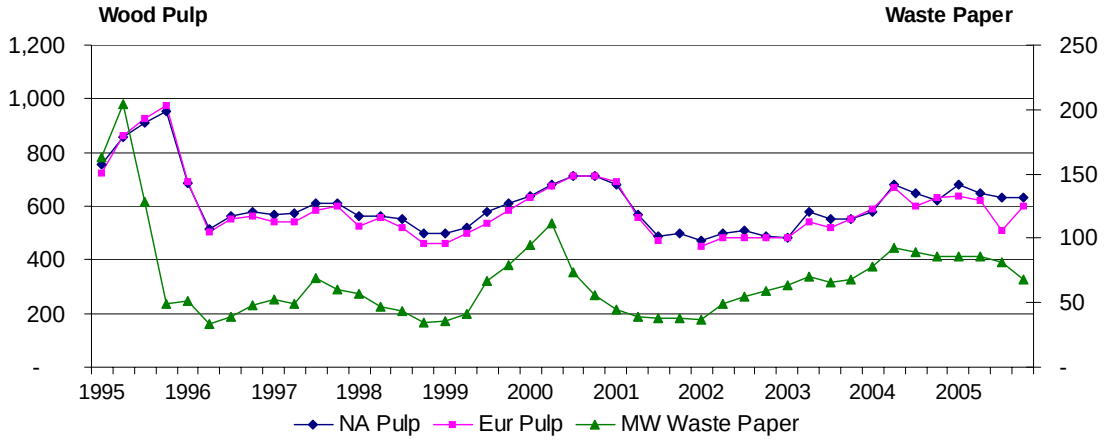
[41] "Market Pulp Sees Improved Demand, Rising Production vs. Last Year," 11.

[42] "Market Pulp Has Strong Early 2003, But Slow Summer Hampers Producers," 7.

[43] "Pulp Prices Expected to Climb Further Amid Rising Economy, Paper Markets," 13.

[44] "Market Pulp Expected to See Price Pressure on New Capacity," 13.

Figure 4-2 North American and European prices for wood pulp[1] Midwest U.S. price for waste,[2] 1995–2005 dollars per metric ton



Source: Pulp & Paper, *2001 North American Factbook, Pulp & Paper–Annual market reviews*, Paperloop.com archives, and *Official Board Markets*.

[1] Wood pulp prices are for northern bleached softwood kraft pulp (NBSK).

[2] The prices shown are quarterly averages of the reported prices of four important grades of waste paper; old corrugated containers (OCC), old news print (ONP), mixed waste (MW), and sorted white ledger (SOL); weighted by annual U.S. recoveries for each of those grade.

Figure 4-2 shows waste paper prices in the U.S. Midwest market,[45] which are likewise highly volatile.[46] Although it is not a perfect substitute for wood pulp, waste paper price trends nevertheless closely tracked wood pulp price trends during the period.[47] In the fall of 2005, U.S. export prices for old corrugated containers (OCC) declined as a result of continued oversupply at U.S. paper mills. Chinese OCC demand was steady,[48] but the main purchasers, Chinese containerboard producers, were limiting their purchases due to soft domestic demand for corrugated boxes.[49]

The steep increase in Chinese consumption of wood pulp (4.4 percent) and waste paper (13.6 percent) between 1995 and 2004 has not yet put upward pressure on global prices for either wood pulp or waste paper. With regard to wood pulp, this result was due in part to relatively flat consumption by other consuming countries and because the annual increase in consumption of 15 million metric tons was matched by almost 20 million metric tons of additional annual production capacity.[50] The full impact of strong Chinese demand on global waste paper prices has been mitigated by capacity closures and generally weak demand in the United States and Europe.[51]

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[45] U.S. prices are reportedly critical in determining global prices. "Recovered Paper: China Casts a Wide Supply Net."

[46] In the United States, waste paper is generally sold F.O.B. seller's dock. Control of inbound shipments allows mills to take advantage of backhaul opportunities in conjunction with their outbound shipments. Mills may also trade waste paper with other firms to lower freight costs.

[47] De-inked pulp, the product of recycling various grades of waste paper, performs roughly the same as southern bleached hardwood kraft pulp (SBHK). Prices of de-inked pulp are on par with those for SBHK. U.S. International Trade Commission, *Industry & Trade Summary, Wood Pulp and Waste Paper 2005*, 15.

[48] "Oversupply of OCC Keys Decline in the U.S. Export Prices to China; ONP No. 8 Increases in West."

[49] "OCC Prices Slip in China and Southeast Asia."

[50] "1994–95 The World's Pulp, Paper, and Board Industry: Production and Trade," 25, and Pulp & Paper International, *Annual Review*.

[51] "Recovered Paper: China Casts a Wide Supply Net."

Trade Trends[52]

In 2004, the value of global trade in forest products based on official statistics surpassed $495 billion dollars. The United States accounted for 13.1 percent of the reported trade in 2004. Trade by the top five countries,[53] which accounted for 40.7 percent of reported global trade in 2004, advanced at a moderate pace (an average annual rate of 5.4 percent since 1997). In contrast, China's total trade increased at a much greater rate (14.0 percent between 1995 and 2004), and was $23 billion or 4.6 percent of global trade in 2004.

In 2004, China was the largest importer of wood pulp and waste paper,[54] accounting for $4.6 billion or 19.5 percent of total reported global imports of $23.8 billion. The top five importers, China, Germany, the United States, Italy, and South Korea, accounted for 54.4 percent of reported imports in 2004. China's imports of wood pulp and waste paper expanded at an average annual rate of 31.2 percent during 1997-2004, while the value of imports by other major importing countries increased at average annual rates of 1.7 percent to 5.8 percent.

In 2004, the largest exporter of wood pulp and waste paper was Canada, which accounted for 9.0 percent of the $49.6 billion of reported exports. The top five exporters, Canada, the United States, Sweden, Brazil, and Chile, accounted for 26.2 percent of reported global exports in 2004. Four of the top five exporters, Canada, Sweden, Brazil, and Chile, are well-endowed with forest resources, but with relatively small domestic markets. Indicative of the migration of wood pulp manufacturing toward South America, exports from Brazil and Chile between 1995 and 2004 increased at average annual rates of over 8 percent, far outpacing the growth of exports from traditional suppliers, Canada, the United States, and Sweden.

The largest importer of packaging and printing papers was Germany, which accounted for 11.1 percent of total reported imports of $53.0 billion in 2004. The top five importers, Germany, the United States, the United Kingdom, France, and China, accounted for 41.8 percent of reported imports in 2004. During 1997-2004, the value of China's imports of packaging and printing papers increased at an average annual rate of 5.4 percent and appears to be leveling off due to growing domestic production. The average annual rate of increase during 2000-2004 was only 3.5 percent.

On a regional basis, other Asian countries and North America remained the top suppliers of packaging and printing papers to China between 1995 and 2004 although those regions lost market share to other regions, particularly Scandinavia. China's top suppliers of packaging and printing papers in 2004 were the United States, South Korea, Taiwan, Japan, and

[52] The source of all reported trade figures is the *World Trade Atlas.* 1997 was the first year for which reported imports were available for all the countries examined.

[53] Countries other than the United States in the top five were Germany, Canada, France, and China.

[54] As defined by HS heading 4703 and 4707.

Sweden, which collectively accounted for 57 percent of China's imports (figure 4-3). With respect to imports of wood pulp and waste paper, North America and other Asian countries remained the top suppliers to China between 1995 and 2004. However, North America lost market share to other regions, with South America and Europe posting strong gains (figure 4-4).[55]

China's emphasis on developing higher value-added manufacturing and the rapid expansion of its paper industry[56] have led to a significant shift in the mix of its pulp and paper imports during 1994-2005. The growth rate for imports of wood pulp and waste paper far exceeded that for imports of packaging and printing papers (table 4-4). The share of Chinese forest products imports composed of packaging and printing papers decreased from 31 percent to 22 percent during 1995-2004, and the share composed of wood pulp and waste paper increased from 15 percent to 31 percent. Increased global recoveries of waste paper during the period provided much of the fiber for China's expanding paper industry. The increase in annual waste paper usage in China between 1995 and 2004 accounted for 36 percent of the increase in annual global recoveries during the period.

The United States shipped 7.7 million metric tons of waste paper to China in 2005. China is purchasing more waste paper from Europe and Japan in order to reduce its exposure in the U.S. market, which reportedly has dampened price fluctuations in the U.S. market.[57] However, the extent to which increasing quantities of suitable waste paper continue to be available to China depends on the practical limits of recovery and the quality of the remaining waste paper. Industry representatives expect that waste paper prices will increase as higher recovery rates tighten the supply/demand balance.[58] Higher recovery rates will accentuate quality issues. China already attempts to control the amount of impurities in scrap shipments by requiring that foreign exporters obtain scrap import licenses.[59]

[55] China's top suppliers of wood pulp and waste paper in 2004 were the United States, Canada, Indonesia, Russia, and Brazil, which accounted for 69 percent of China's imports.

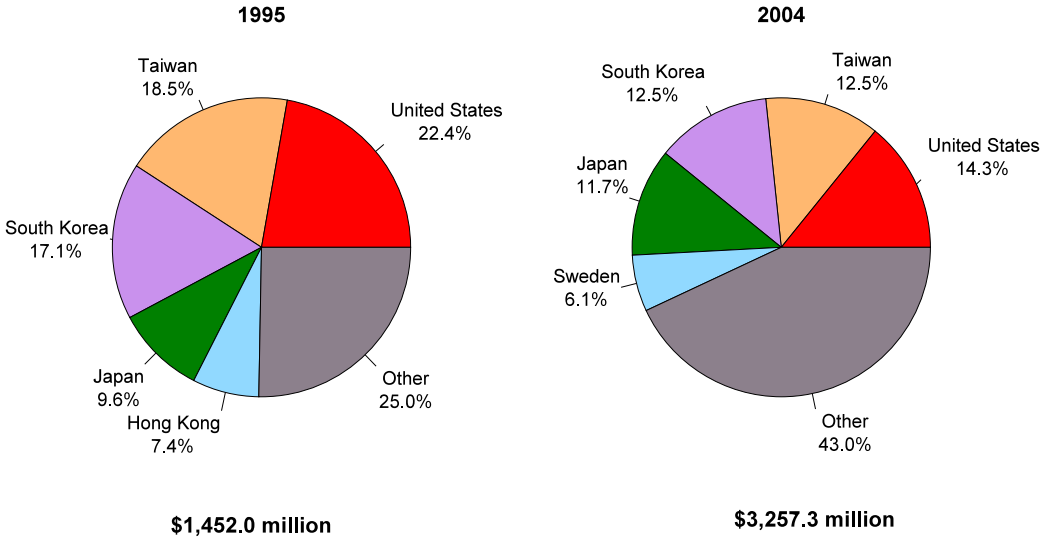
[56] Pitman B. Potter, "China's Needs and Goals: Political and Economic Issues."

[57] Telephone interview by staff with industry representative on January 4, 2006.

[58] Ibid.

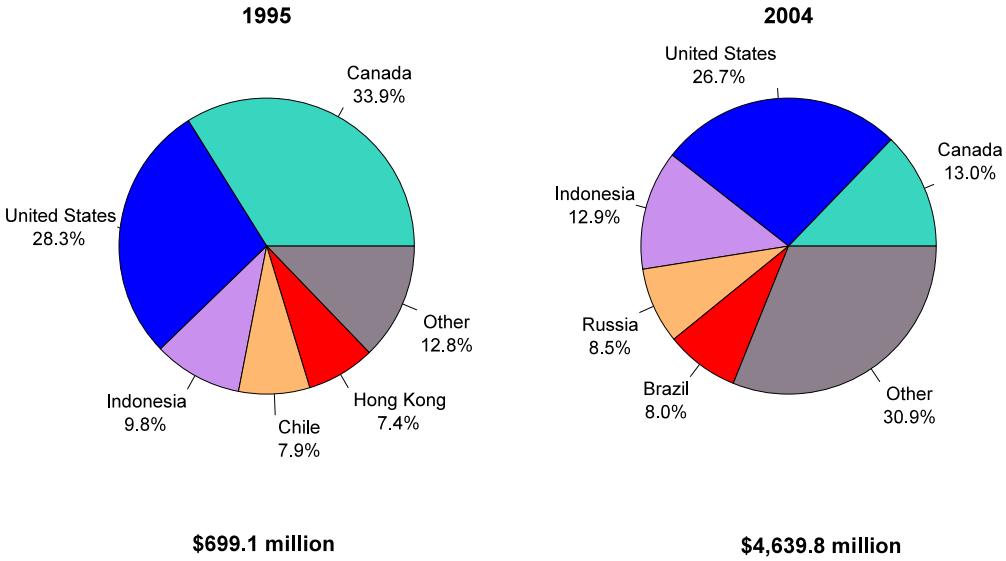
[59] "Chinese Official at ISRI Meeting: Send Your Scrap, Keep Your Trash," found at http://www.amm.com and retrieved April 20, 2005.

Figure 4-3 Packaging and printing papers, Chinese imports by country, 1995 and 2004



Source: *World Trade Atlas*.

Figure 4-4 Wood pulp and waste products, Chinese imports by country, 1995 and 2004



Source: *World Trade Atlas.*

Wood Products

Demand

Factors broadly affecting demand

Although wood is used to manufacture a wide variety of different products, by far the largest quantity of wood products is used for residential construction and/or remodeling and commercial construction. Therefore, residential housing markets are a major driver of demand for wood products. Housing markets are driven by short term economic cycles and may also be influenced by long term trends in the number of home buyers and interest rates. Large consuming countries are those where wood frame construction plays a major role in meeting residential housing demand (e.g., the United States, Canada, Japan). Climate and/or cultural preferences in some regions or countries may dictate the use of alternate building materials such as masonry.

End uses for particular logs depend on the size and quality of the logs, but the cost of transportation typically restricts overseas trade of logs to relatively high value species. Lumber, veneer, and wood chips, the intermediate products resulting from the primary manufacturing of logs, are globally traded commodities.[60] Demand for softwood lumber and softwood plywood, which are used principally as structural elements in residential and commercial construction, is linked directly to housing and construction markets. Major end uses for hardwood lumber and hardwood plywood include shipping pallets, furniture, millwork, cabinets, architectural woodworking, and railroad crossties. Though hardwood is not generally used for structural purposes, demand for many hardwood products (e.g., cabinets, moulding, paneling, furniture) is nevertheless closely linked to housing and construction.

Demand for wood products in China

China represents a vast market for residential construction, but estimates of future demand must account for cultural and political factors. New residential construction in China now exceeds 700 million square meters annually, and commercial construction, which is already booming, is expected to increase in advance of the 2008 Olympics and 2010 World Expo.[61] However, there is a strong cultural aversion to wood frame construction in China. Traditional post and beam construction is regarded as old fashioned and rural.[62] Only 300 wood frame houses were constructed in China out of approximately 24 million mostly masonry housing starts in 2005.[63] It is also unlikely that the Government would encourage the use of wood frame housing, which would put more pressure on already limited domestic wood supplies and work against the policy goal of wood self-sufficiency.[64] Thus, despite ongoing efforts by U.S. industry associations to build market share, Chinese demand for softwood lumber and plywood is likely to remain relatively low.[65]

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[60] Veneer is the primary raw material for the manufacture of plywood.
[61] "North American Hardwood Exports," 7.
[62] Boardman, "China's Government Policy: Support and Subsidies."
[63] Braden, "Opportunities and Constraints for Wood Building Materials: The Challenge of China."
[64] Boardman, "China's Government Policy: Support and Subsidies."
[65] "North American Lumber Exports to China Lagging Year-Ago Pace," 1.

Nevertheless, privatization of the housing market has stimulated demand for larger, higher quality homes with better amenities,[66] and new construction is expected to drive steadily increasing demand for hardwood used for many products inside the home (e.g., flooring, paneling, furniture, cabinets).[67] That said, U.S. industry analysts perceive a shift in Chinese hardwood demand. In the last few years, Chinese imports of hardwood lumber have stagnated, and log imports have increased relative to lumber imports as a result of China's intention to capture the value added by primary manufacturing of the logs.[68] Chinese wood products manufacturers are also expected to seek new suppliers of hardwood lumber, particularly in Eastern Europe.[69]

China's demand in global context

Between 1995 and 2004, the United States remained the largest consumer of lumber (table 4-7). The United States and third-ranked Canada increased their shares of world consumption on the strength of strong domestic housing markets. Japan remained the second largest consumer of lumber, although its consumption decreased due to generally declining housing starts during the period.[70] The decrease in consumption of lumber by China occurred in spite of a large increase in lumber imports and primarily reflects declining Chinese domestic lumber production during 1995-2000,[71] which resulted from the curtailment of domestic log harvests with the implementation of the NFPP.[72]

Table 4-7 Lumber: Top five countries ranked by consumption, 1995 and 2004

	Consumption		Global Market Share		Average Annual Growth Rate
	1995	2004	1995	2004	1995–2004
Country	1,000 Cubic Meters		Percent		
United States	108,403	127,019	27.7	31.1	1.8
Japan	36,247	22,764	9.3	5.6	-5.0
Canada	11,855	21,194	3.0	5.2	6.7
Brazil	17,956	19,330	4.6	4.7	0.8
China	27,946	18,596	7.1	4.6	-4.4
World	391,516	407,782	100.0	100.0	0.5

Source: FAOstat.

[66] Braden, "Opportunities and Constraints for Wood Building Materials:

[67] "North American Hardwood Exports," 7.

[68] "Observations on Trade with China," 3.

[69] Telephone interview by staff with an industry representative on November 14, 2005.

[70] Japanese housing starts in 2004 were approximately 19 percent below the 1995 level. "Housing Starts," and "Housing Starts by Structure," 6.

[71] From 1995 to 2000, Chinese lumber production declined at an average annual rate of 22 percent from 25.6 million cubic meters to 7.3 million cubic meters. FAOstat.

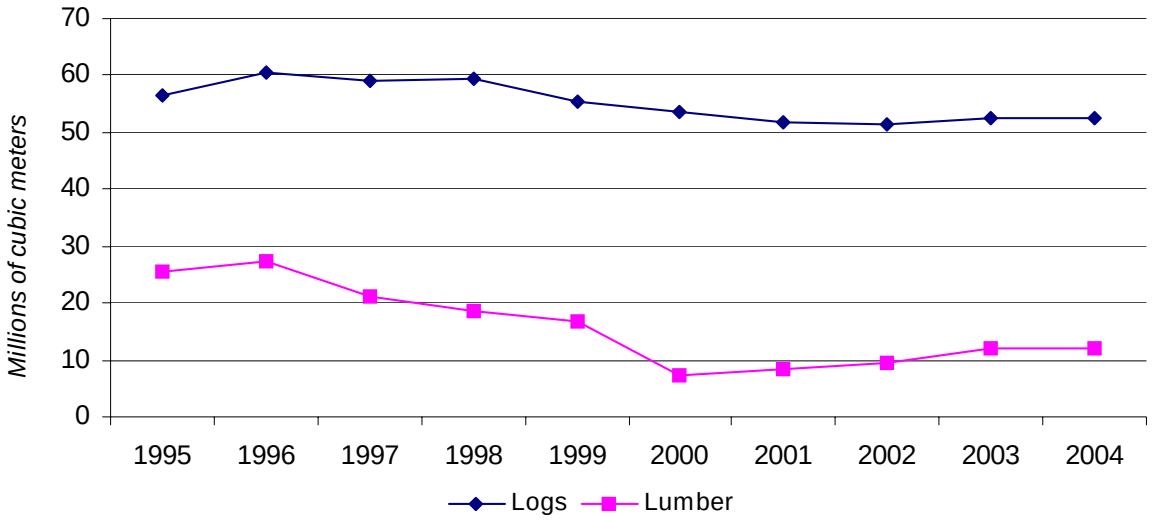
[72] U.S. International Trade Commission, *Conditions of Competition in U.S. Forest Products Trade*, 5-43.

Supply

Supply of wood products in China

Domestic annual production of logs in China began to decline in 1998 with the implementation of the NFPP. Annual production of logs continued to decline until 2001, after which it remained relatively flat (figure 4-5). Likewise, annual production of lumber declined early in the period, but unlike log production, lumber production began to recover in 2000 with the growing availability of imported Russian logs.[73]

Figure 4-5 Chinese production of logs and lumber, 1995–2004



Source: FAOStat.

China's logs and lumber are used to manufacture a wide variety of wood products for both domestic and export markets. China is now the largest producer of plywood in the world and is increasing production of other products such as furniture, medium density fiberboard (MDF), doors, flooring, stair parts, and moulding.[74] In 2004, there were approximately 10,350 saw mills, 4,800 plywood mills, and 370 MDF plants in China.[75]

China's sawmills have the lowest manufacturing cost in the world due to low labor rates, but are generally small and lack newer technology. The favorable labor costs of Chinese wood products plants are partially offset by relatively high log costs.[76] Prior to 1998, China's domestic timber resource was dominated by large diameter logs, but subsequent to the NFPP,

[73] Data from United Nations Food and Agriculture Organization (FAO).
[74] "Report from China," and "China Wood Markets Conference," 5.
[75] Nilsson, "Log Imports: A Long Term Solution to Meeting China's Fiber Needs."
[76] Compared with global average log costs ($57 per cubic meter), China's log costs average $65 per cubic meter for domestic logs and $80 to $120 per cubic meter for imported logs. "Global Lumber Bench marking 2004," 4.

the domestic supply of large diameter logs has been limited.[77] The existing commercial plantations in China are not well aligned with China's growing regional markets, and the rate of adoption of new technology to utilize small diameter logs from plantations has reportedly been slow.[78] Thus, firms generally depend on the import market for large diameter logs.[79]

Because wood products investment in China has increased faster than domestic consumption, most Chinese wood products firms are oriented toward export markets.[80] Chinese firms' success in increasing exports is in part the result of their ability to meet both the logistical requirements and product specifications of U.S. and European importers.[81] The necessity to meet those requirements has driven investment in world class manufacturing facilities for products such as furniture and doors.[82] The Chinese industry has attracted foreign investment in the form of joint ventures with firms from Europe, Hong Kong, and Taiwan, although some investments have reportedly suffered from excess capacity and poor profitability.[83]

China's supply in global context

The United States, Canada, and Russia, all well-endowed with domestic forest resources, remained the top three producers of both logs and lumber between 1995 and 2004 (tables 4-8 and 4-9). Despite a general reduction in U.S. domestic log supplies resulting from decreased harvests from public forests, overall U.S. production of lumber increased due in part to increased lumber yields resulting from sawmill process improvements. There was a general lack of investment in Russia's industry during the 1990s which in part explains

[77] Chan, "How Much Risk? Investment Strategies for China."
[78] Ibid.
[79] Ibid.
[80] "China Wood Markets Conference," 4.
[81] "China's Transformation Through the Lense of Commercial Trade."
[82] Taylor, "China's Wood Products Industry: Competitiveness Rating in Exports Markets," 14.
[83] U.S. International Trade Commission, *Conditions of Competition in U.S. Forest Products Trade*, 5-46, and "China Wood Markets Conference," 4.

Table 4-8 Sawlogs and veneer logs: Top five countries ranked by production, 1995 and 2004

	Production		Share of Global Production		Average annual growth rate
	1995	2004	1995	2004	1995–2004
Country	1,000 Cubic Meters		Percent		
United States	242,874	234,67	25.9	24.4	-0.4
Canada	148,836	166,42	15.9	17.3	1.2
Russia	52,550	58,75	5.6	6.1	1.2
China	56,523	52,62	6.0	5.5	-0.8
Brazil	47,779	49,29	5.1	5.1	0.3
World	936,947	959,90	100.0	100.0	0.3

Source: FAOstat.

Table 4-9 Lumber: Top five countries ranked by production, 1995 and 2004

	Production		Share of Global Production		Average Annual Growth Rate
	1995	2004	1995	2004	1995–2004
Country	1,000 cubic meters		Percent		
United States	84,140	87,436	21.5	21.4	0.4
Canada	45,444	60,655	11.6	14.8	3.3
Russia	26,500	21,500	6.8	5.3	-2.3
Brazil	19,091	21,200	4.9	5.2	1.2
Germany	14,105	19,051	3.6	4.7	3.4
World	391,977	409,385	100.0	100.0	0.5

Source: FAOstat.

why Russia's lumber production decreased in spite of increased production of logs between 1995 and 2004.[84] Widespread illegal logging, outdated processing facilities, and low levels of foreign investment hinder Russia's wood products industry, and doing business in Russia still involves various levels of corruption.[85] Russian firms have focused on exporting logs and lumber during the last five years due to high export pricing.[86]

Price Trends

The combination of increasing Russian softwood log and lumber exports and expanding Chinese manufacturing capacity was expected to affect global markets for softwood products.[87] Less clear, however, has been the potential impact of China's increased demand for hardwoods, which accounts for most of China's increased imports of logs and lumber from the United States, on global prices for hardwood logs and lumber.[88] Since the early 1990s, U.S. stumpage prices[89] for hardwood sawlogs have risen dramatically, driven by

[84] U.S. International Trade Commission, *Conditions of Competition in U.S. Forest Products Trade*, 6-32.

[85] "Inefficient Use of Resources Stunts Growth in Russia's Timber Industry," 2, and "China Wood Markets Conference," 4.

[86] "Global Lumber Outlook 2006," 3.

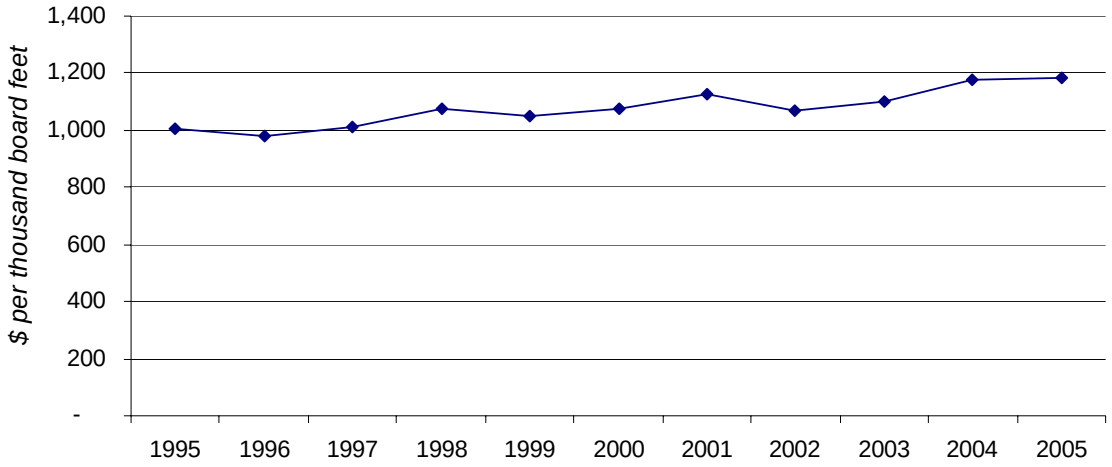
[87] "China Wood Markets Conference," 4.

[88] Approximately 87 percent of Chinese imports of U.S. logs and 90 percent of Chinese imports of U.S. lumber are hardwoods. USITC dataweb.

[89] Stumpage is the price of standing trees, which is paid to forest landowners, prior to or during harvesting.

strong global demand and limited supplies.[90] U.S. prices for hardwood lumber have also increased. Between 1995 and 2004, the average U.S. price of various heavily exported grades of hardwood lumber increased at an average annual rate of 1.6 percent (figure 4-6).

Figure 4-6 Average U.S. mill prices for kiln-dried hardwood lumber, 1995–2005[1]



Source: Hardwood Review, Hardwood Market Report.

[1] The average prices shown were computed by averaging reported January prices (f.o.b. mill) for the 12 grades of kiln-dried hardwood lumber that are included in the *Hardwood Review* North American Hardwood Lumber Export Price Index as reported by the *Hardwood Market Report*.

The Chinese market is reportedly very sensitive to price.[91] Attempting to offset log price increases, Chinese wood products firms tried using more domestic wood and/or lower quality wood but apparently found it difficult to process low grade logs profitably, even with low labor costs.[92] Chinese firms are also less particular than other customers about the species used to manufacture their products, switching species based on price.[93] U.S. industry sources have noted that when the price of a particular species or grade reaches a certain threshold, it tends to trigger a shift in Chinese purchasing patterns to another species. Thus, as the quantities of U.S. lumber exports to China have increased, the unit values have decreased.[94]

There have been widespread reports that illegally harvested logs are being imported into China.[95] Illegal logging causes harvests to exceed sustainable levels and has had a negative impact on global log prices.[96] Strict definitions of what constitutes illegal logging vary, but a relatively large portion of China's log imports may be from questionable sources. For instance, it has been estimated that 50 percent of China's hardwood log imports from Russia and West Africa are from suspicious or illegal origins and that seven out of ten large

[90] "Looming Declines in Demand Bring Uncertainty to U.S. Hardwood Sawlog Prices."
[91] Braden, "Opportunities and Constraints for Wood Building Materials: The Challenge of China."
[92] "China Wood Markets Conference," 4, 5, and "North American Hardwood Exports," 1.
[93] "Our View of China," 2, and telephone interview by staff with an industry representative on November 14, 2005.
[94] "Observations on Trade with China," 2.
[95] "China Wood Markets Conference," 4.
[96] Don G. Roberts, "Global Investment Trends in the Forest Products Sector."

suppliers of logs to China have generally poor governance of natural resources.[97] Eliminating illegal logging would affect both the quantity and price of forest resources obtained by China. As more forests are managed for sustainable harvests, as governments curtail illegal harvests, and as forest certification programs spread, global markets are expected to undergo significant change, and global prices can be expected to rise.[98]

Trade Trends[99]

Between 1995 and 2004, the value of Chinese imports of logs and lumber expanded at an average annual rate of 26.1 percent (see table 4-4). In 2004, Russia, Malaysia, the United States, Indonesia, and Thailand were the largest suppliers to China and collectively accounted for 63 percent of China's imports (figure 4-7). Chinese log imports represent 20 percent of global softwood trade and 26 percent of global hardwood trade.[100] Chinese imports from Russia increased the most dramatically, expanding at an average annual rate of 51.0 percent compared with 26.0 percent for imports from the United States. China accounted for almost all of the increase in Russia's log exports between 2000 and 2004.[101] The large increase resulted from a combination of factors: the increased harvesting of Siberian timber, inefficient mills and/or lack of capacity in Russia, Russia's relatively easy overland access to China, and aggressive investment in new wood products processing capacity in China.[102]

Beginning in 1998, the United States overtook Japan to become the largest importer of logs and lumber from the world. In 2004, the United States accounted for 22.0 percent of total reported global imports of $41.1 billion, and the top five importers, the United States, Japan, China, Italy, and the United Kingdom, accounted for 55.7 percent. With respect to wood products, the United States, Japan, Italy, and the United Kingdom are mature markets. During 1997-2004, the value of Japanese imports of logs and lumber declined at an average annual rate of 7.4 percent, and the value of imports in the other countries increased steadily at average annual rates ranging from 1.7 percent to 2.8 percent. However, with the rapid expansion of its wood products industry, China's imports of logs and lumber increased at an average annual rate of 23.6 percent.

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[97] Kerstin S. Canby, "Meeting China's Fiber Demand: Is China's Supply Legal or Illegal? What is the International Response?," and "Our View of China," 1.

[98] "North American Hardwood Exports," 7.

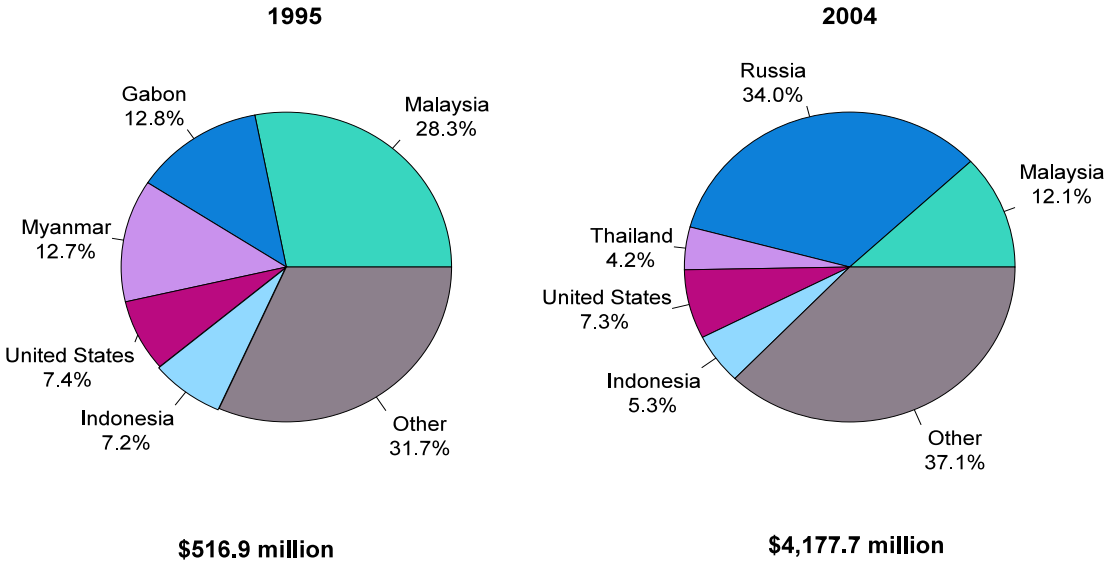
[99] The source of all reported trade figures is the World Trade Atlas. 1997 was the first year for which reported imports are available for all the countries examined.

[100] "China Wood Markets Conference," 4.

[101] Van Leeuwen, "What Is Russia's Fit with China," 3.

[102] "Inefficient Use of Resources Stunts Growth in Russia's Timber Industry," 2, and Van Leeuwen, "What Is Russia's Fit with China," 3.

Figure 4-7 Logs and lumber, Chinese imports by country, 1995 and 2004 (million dollars)



Source: World Trade Atlas.

In 2004, the largest global exporter of logs and lumber was Canada, which accounted for 26.1 percent of the $36.1 billion of reported exports. The top five exporters, Canada, Russia, the United States, Sweden, and Finland, accounted for 59.2 percent of the reported global exports in 2004. During 1997-2004, the value of logs and lumber exports from Canada and the United States declined at average annual rates of 0.3 percent and 3.3 percent respectively, and those from Sweden and Finland both increased at about 1 percent annually. On the strength of increasing harvests in Siberia and the Russian Far East, Russia's logs and lumber exports increased rapidly at an average annual rate of 12.5 percent.

North American exports of logs and lumber to China and Hong Kong grew rapidly between 1995 and 2004, with U.S. exports increasing at an average annual rate of 24.4 percent and Canadian exports increasing by 19.0 percent. Other export markets were generally bleak for North American firms; U.S. and Canadian exports to other offshore markets (e.g., Japan, Europe, Caribbean) declined at average annual rates of 8.0 percent and 4.5 percent, respectively. General factors contributing to the decline were global recession, the strength of the U.S. dollar, increasing capacity in other regions, displacement by lower cost competitors, and a reduction in the U.S. supply of large-diameter logs.[103]

[103] Softwood production in Europe was once dominated by traditional suppliers, Sweden and Finland. However, newer, more efficient mills, some in Central Europe or Eastern Europe, are becoming an integral part of European production capacity. "European Softwood Producers Poised to Expand," 1, "Poland Making Strides in Wood Products Industry," 1. "Exporters Continue to Lose Market Share," 1, "Export Market Offering U.S. Mills Few Opportunities," 1, "Global Slowdown, Competition Hinder Export Sales," 1.

CHAPTER 5
Ferrous Scrap[1]

Summary of Conclusions

China has become the second-leading importer of ferrous scrap in the world, after Turkey. Imports grew at an average annual rate of 26 percent between 1999 to 2004 as the rapid growth of China's steel industry and the lower growth rate for the primary iron-producing industries in China increased the country's demand for ferrous scrap. Domestic production of scrap within China has not kept pace with consumption, because the reservoir of steel products to be scrapped is low in relation to the current rate of consumption. The high rate of growth of demand for ferrous scrap in China and other nations has caused scrap prices worldwide to increase to record levels and also to fluctuate widely in reaction to uncertainties in the market.

Demand

Factors Broadly Affecting Demand

Ferrous scrap is a raw material for the production of steel products and ferrous castings, and so demand for scrap is closely linked to production trends in the steel industry. Steel and castings production are commonly established in developing nations to provide a foundation for growing manufacturing economies. Additionally, many developing nations with low labor costs, low real estate costs, low energy costs, reliable access to transportation, and other positive factors are attractive sites for steelmaking, even if they must import iron ore or scrap from other sources. Under normal market circumstances, ferrous scrap is a lower cost alternative to primary iron products such as pig iron and direct-reduced iron, which are produced directly from iron ore.

Demand for Ferrous Scrap in China

As in other developing countries, the expansion of China's scrap consumption has been driven by its production of steel mill products and ferrous castings. Production of crude steel and castings increased from 106 million tons in 1995 to 136 million tons in 1999, and to 293 million tons in 2004 (table 5-1). The steel industry in China has been and remains primarily dependent on primary iron produced directly from iron ore. Throughout the period, however, China's production of primary iron in the forms of pig iron and direct-reduced iron increased at a lower rate; 5 percent per year during 1995 to 1999 and 15 percent per year during 1999 to 2004, than the average annual rate of growth of steel and castings production; 6 percent during 1995 to 1999 and 17 percent during 1999 to 2004. Chinese scrap consumption has made up the difference, increasing from approximately 19 million tons in 1995 to 29 million tons in 1999 and to 76 million tons in 2004, representing average

[1] Ferrous scrap consists of discarded pieces of metal, containing primarily metallic iron, and suitable only for remelting. For purposes of trade data in this discussion, ferrous scrap comprises HTSUS heading 7204.

Table 5-1 Metallics balance for China (thousand metric tons)

Year	Crude Steel Production	Castings Production	Total Crude Steel Plus Castings	Total Metallics Requirement ([1])	Primary Iron Apparent Consumption	Net Imports for Consumption of Scrap	Scrap Produced in China([1])
1995	95,360	10,645	106,005	119,000	100,013	1,237	18,000
1996	101,237	10,152	111,389	125,000	103,699	1,228	20,000
1997	108,911	10,252	119,163	134,000	109,630	1,761	23,000
1998	114,588	11,391	125,979	142,000	116,189	1,974	23,000
1999	123,954	11,688	135,642	152,000	123,824	3,278	25,000
2000	127,124	13,317	140,441	158,000	127,837	5,052	25,000
2001	150,853	13,752	164,605	185,000	147,661	9,766	28,000
2002	182,182	14,979	197,161	222,000	172,507	7,577	41,000
2003	222,376	16,600	238,976	269,000	215,564	9,290	44,000
2004	272,456	20,271	292,727	329,000	253,311	10,219	65,000

Source: IISI and Modern Casting.

[1] Estimates are rounded to the nearest million tons.

annual growth rates of 10.5 percent during 1995 to 1999 and 21.5 percent during 1999 to 2004 (table 5-2).[2]

The Chinese growth rate of steel production is expected to moderate in 2006, as demand for steel products has abated, but an increase to at least 450 million tons is generally expected by 2010.[3] Production of pig iron in China increased by 30 percent in 2005, to 328 million tons, a more rapid increase than that of steel production, which increased only 28 percent. As a result, demand for scrap moderated somewhat in 2005, but may resume its increase in future years. Further increases in pig iron production are anticipated, to over 400 million tons by 2010, representing an increase of about 5 percent per year. The fact that pig iron production increased in 2005 at a much higher rate than steel production has already resulted in some relief in the demand for scrap, and there has been an easing of scrap prices worldwide. Present indications that future growth of pig iron production in China will be less than that of steel production may indicate a return to increased imported scrap demand and higher prices, worldwide.

Supply

Factors Broadly Affecting Supply

Ferrous scrap is produced as a result of two broad economic activities: manufacture of steel and steel-containing products (prompt scrap), and recovery of steel from used articles and demolished structures (obsolete scrap). The production of prompt industrial scrap, which results from the use of new steel in construction and manufacturing, is more-or-less proportional to the amount of steel consumed; however, manufacturing activities tend to generate more scrap in relation to steel consumption than do construction-related activities. As a result, a greater percentage of steel consumed becomes scrap in an economy where steel is used primarily for manufacturing, such as that of the United States, than in an economy where a greater share of steel is used for construction, such as in China. In 2004, for example, apparent steel consumption in the United States was 130 million tons of steel, of which an estimated 23 million tons (18 percent) became scrap.[4] In China, only an estimated 13 percent of the 309 million tons of steel products consumed in 2004 became scrap, resulting in 41 million tons of scrap.[5] World production/consumption of ferrous scrap was an estimated 458 million metric tons (tons) in 2004, having increased in volume from 307 million tons in 1995 and 364 million tons in 1999, which represents average annual growth of 4.3 percent during 1995 to 1999 and 4.7 percent during 1999 to 2004 (table 5-2).

[2] Estimated by USITC staff based on iron and steel production.

[3] For example, a steel industry analyst projects crude steel production of 467 million tons in China in 2010. World Steel Dynamics. *Chinese Steel: Facts and Forecasts to 2010*, October 2005, 55.

[4] See Michael D. Fenton, *Iron and Steel Recycling in the United States in 1998,* U.S. Geological Survey Circular 1196-G, for model for estimating production of prompt and obsolete scrap in the United States.

[5] World Steel Dynamics, *Steel Strategist #31, The Age of Discontinuity,* 59.

Table 5-2 Annual consumption, production, and trade of ferrous scrap (million metric tons)

United States	1995	1999	2004
Consumption	51.0	51.5	54.4
Annual growth rate percent		0.4	1.3
Imports	2.1	3.7	4.7
Exports	10.4	5.5	12.0
Production	59.3	52.8	61.7
Annual growth rate percent		-2.9	3.2

China	1995	1999	2004
Consumption	19.2	28.6	75.6
Annual growth rate percent		10.5	21.5
Imports	1.3	3.3	10.2
Exports	0.1	0.1	0.0
Production	18.0	25.3	65.4
Annual growth rate percent		8.9	20.9

World	1995	1999	2004
Production	307	364	458
Annual growth rate percent		4.3	4.7

Sources: WSD, *Steel Strategist #31;* USGS, *Iron and Steel Scrap*, Chapter in Minerals Yearbook, various years; and *World Trade Atlas*.

Note: Excludes home scrap.

Supply of Ferrous Scrap in China

Obsolete scrap from the demolition of structures and the scrapping of obsolete articles, especially automobiles, is a more important source of scrap than prompt scrap in developed countries such as the United States. For 2004, the estimated quantity of steel scrap from obsolete sources in the United States is 39 million tons.[6] China, unlike the United States, lacks a vast reservoir of old manufactured products and buildings to be recycled as scrap. As a result, obsolete scrap is a less important source in China than in the United States, resulting in only about 24 million tons of scrap in 2004. Hence, China relies on imports of scrap, which have increased fourfold from 1995 to 2004, and on domestically-produced prompt scrap. However, the size of the Chinese scrap reservoir is growing rapidly, but from a small base, and the amount of obsolete scrap available will increase in future years.

On July 20, 2005, China's National Development and Reform Commission published China's Steel Industry Development Policy, which has been described as the blueprint for the Chinese steel industry over the next decade. In their planning, China recognizes that its production of obsolete ferrous scrap will increase as its economy matures, and plans that the proportion of iron ore used in steelmaking shall be gradually reduced while that of scrap

[6] See Fenton, *Iron and Steel Recycling*.

steel shall be increased.[7] In addition, the policy urges that exports of scrap, along with certain processed products that represent a high level of energy consumption and heavy pollution should be restricted. The policy urges that tax reimbursements for exporting these products be reduced or eliminated.[8]

Price Trends

Increased world demand has led to increases in scrap prices in recent years (figure 5-1). The selling price of No. 1 Heavy Melting Steel scrap[9] in the United States increased slowly from 2001 through the first half of 2003 and more sharply in late 2003, before fluctuating in a higher and broader range through 2005, mostly from about $180 to $250 per long ton. The price of automobile bundles[10] followed a similar pattern, except that its increase in 2004 was much greater, as it climbed to almost $450 per long ton in September 2004, before dropping back to a level that was still more than double the price during the 2001 to 2003 period.[11]

Scrap prices in China followed a similar pattern, but with less month-to-month fluctuation. The price index of Heavy General Scrap in China during 2001 to 2002 was steady at an index of 75 (equivalent to $119 per long ton). The price increased steadily through 2003, dropped briefly in May–June 2004, then renewed its increase, finishing 2004 at an all-time high index of 163 (equivalent to $258 per long ton). Scrap prices in China declined in 2005 and continue to fluctuate, although at levels above those of 2001. While China's imports of ferrous scrap have increased quickly over the past decade, it is not clear from the existing economic literature how much of the observed increase in global prices is due to the increase in China's demand.[12]

Trade Trends

Ferrous scrap is widely and competitively traded. Ferrous scrap exporting nations are those with vast reservoirs of steel that have been in service for many years. The United States perennially generates far more scrap than it consumes and is a leading exporter of steel scrap. During 1995–2004, U.S. exports to Turkey and Korea declined while exports to China increased (table 5-3). Russia, historically a large steel producing nation, has a huge reservoir of scrap and has emerged as the leading exporting nation in the world, with its exports increasing from 2 million tons in 1995 to 13 million tons in 2004. Ukraine, Kazakhstan, and Romania have also become leading exporters of scrap. Scrap production within the European Union varies widely and most EU trade in scrap is internal, with its northern

[7] National Development and Reform Commission, People's Republic of China, *Steel Industry Development Policy*, Article 35.

[8] Ibid., Article 30.

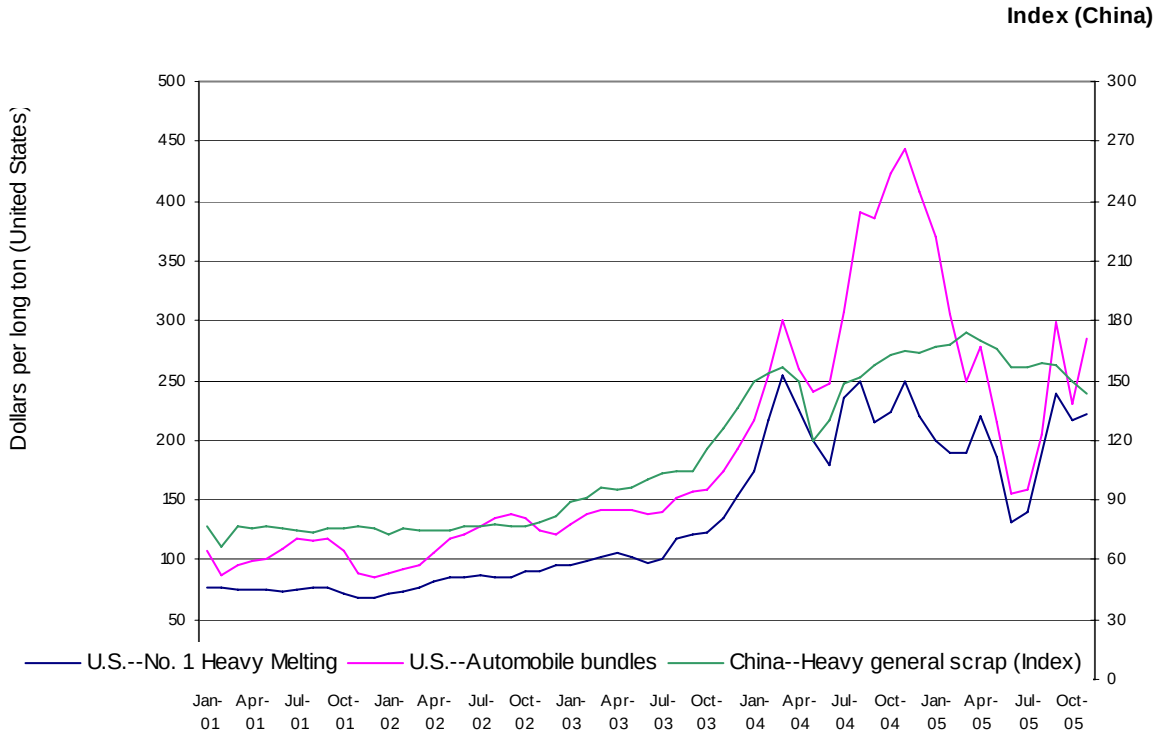
[9] No. 1 Heavy Melting Steel is the benchmark ordinary steel scrap, largely comprising plate and structural steel from demolished structures.

[10] Automobile Bundle scrap includes trimmings from the manufacture of automobile bodies, which have been compacted into bundles for ease of handling. Such scrap is highly prized because of its consistent chemical content with low level of harmful residual elements. It is the most desirable and highest priced of non-alloy, non-stainless steel scrap grades.

[11] *Purchasing Magazine*, Steel Transaction Price Report.

[12] For additional detail, see the appendix.

Figure 5-1 Ferrous scrap prices in the United States and China, monthly, 2001-2005



Source: Purchasing Magazine, Steelhome.cn.

Table 5-3 Major destinations of U.S. exports of ferrous scrap (million metric tons)

Country	1994	1999	2004
China	0.2	0.4	3.0
Canada	1.7	1.7	2.2
Korea	2.6	1.9	1.9
Mexico	0.7	0.8	1.5
Thailand	0.1	0.1	0.8
Turkey	1.2	([1])	0.6
Malaysia	0.4	([1])	0.4
India	0.4	([1])	0.3
All others	1.5	0.6	1.1
Total	8.8	5.5	11.8

Source: Official trade statistics.

[1] Less than 0.1, included in “All others”.

nations generally exporting to the southern nations. The EU is a relatively minor net exporter of scrap. China produces some ferrous scrap, as noted above, but is not a scrap exporter.

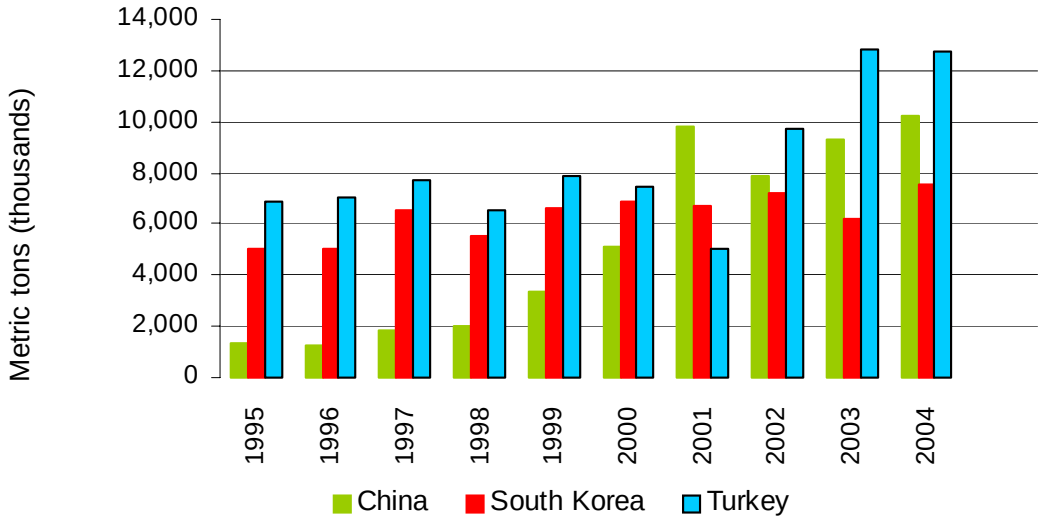
Global trade in ferrous scrap nearly doubled from 1995 to 2004, reaching 96 million tons in 2004, driven by increased consumption in China and other Asian nations including Taiwan, South Korea, Malaysia, Indonesia, and Thailand. Most of the growth in trade has occurred in the last 5 years, as higher prices have spurred recovery of obsolete scrap throughout the world. Exports increased primarily from Russia (an increase of 11.1 million tons), Ukraine (2.1 million tons), Kazakhstan (1.8 million tons), and eastern Europe (4.3 million tons). Japan has changed from a net importer of 0.3 million tons of scrap to a net exporter of 6.5 million tons, representing a total shift of 6.8 million tons. Exports increased from other Asian nations including Hong Kong, the Philippines, and Singapore.

The leading importing nations for ferrous scrap from 1995 to 2004 were Turkey, China, and Korea. Turkey, with a steel industry heavily dependent on scrap, has been the leading importing nation over the period, and its imports have increased, from 7 million tons in 1995 to 13 million tons in 2004 (figure 5-2). Imports by Korea also have increased, but at a lower rate, from 5 million tons in 1994 to 7 million tons in 2004.

China's steel industry has been growing at a prodigious rate, and production of scrap in China has increased at a slower rate than demand, resulting in increased reliance on imported scrap. China's net imports of scrap increased from about 1 million tons in 1995 to 3 million tons in 1999, and to over 10 million tons in 2004.[13] The United States was the leading source of scrap for China in 2004, followed by Kazakhstan, Japan, Hong Kong, and Russia (figure 5-3). Over the same period, many other major Asian markets increased their scrap imports. China accounted for the highest increase (8.8 million tons), followed by Turkey (5.1 million tons) and other Asian steel-producing countries (9.3 million tons).

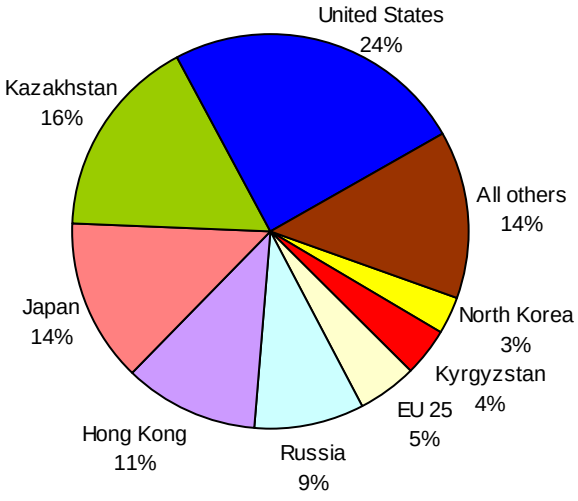
[13] International Iron and Steel Institute, *Annual Statistical Report*, various issues.

Figure 5-2 Ferrous scrap imports by major importing countries, 1995-2004



Source: *Global Trade Atlas*, and International Iron and Steel Institute.

Figure 5-3 Major sources of China imports of ferrous scrap, 2004



Source: *Global Trade Atlas.*

CHAPTER 6
Next Steps and Suggestions for Future Research

This paper examines the effects of increasing Chinese demand for four selected commodities on the global market for each during the 1995-2004 period, the latest available 10-year period. In each case, we have analyzed the extent to which Chinese consumption of each commodity has increased over the decade, and whether this has led to an increase in global market prices, or to other changes in the markets for crude petroleum, unwrought aluminum, forest products, and ferrous scrap. We have not attempted to provide an in-depth forecast of future events in each commodity-related market, other than to briefly point to emerging trends. The study found varying results for each of the four commodities, summarized in the Executive Summary and presented in detail in chapters 2 through 5. The remainder of this concluding section briefly presents ideas for extending this study's analysis of China's impact on global commodity markets.

This study did not attempt a rigorous analysis of the specified commodity markets beyond the 2004 data year, but that is an important next step. Is Chinese demand for these commodities likely to continue along the same trend lines that we have witnessed during the 1995-2004 period? There are of course two sides to the question of the overall impact of Chinese demand on global markets, the question of increasing Chinese demand/consumption, and the question of worldwide supply/production trends. On the demand side, increasing environmental pressure in China may well induce that country to find ways to curtail its crude petroleum consumption, for example, leading to a downward shift in expected Chinese demand. There have also been reports of some low-skilled manufacturing moving outside of China, to Vietnam and other countries, in response to rising wages in China. This may have the longer term effect of weakening demand for commodity inputs. In contrast, continued foreign or domestic investment in new Chinese manufacturing facilities may lead to increased consumption of commodities, beyond the level predicted by current trends. Additional construction of oil-fired power plants may lead to greater-than-expected increases in crude petroleum consumption.

On the supply side, closer scrutiny of market conditions, new technologies, additional exploration for oil and bauxite deposits, and other factors affecting the market for each of the four commodities discussed in the study may also yield changes in predicted future production and supply trends. For the crude petroleum market, political conditions have a particularly strong influence on the global market supply and on prices. Recent events, including political unrest in Nigeria and the possibility of U.N.-imposed sanctions on Iran, have strongly affected crude petroleum prices in recent months.

Macroeconomic and political conditions beyond the purview of the specific industries discussed here also may have profound effects on global markets for commodities in general and for these four commodities in particular. An economic slowdown in the United States or Europe would dampen global demand for crude petroleum and other commodities, leading to lower worldwide prices even in the face of expanded Chinese consumption. For example, higher interest rates in the United States likely would lead to a reduction in building starts, dampening global demand for both aluminum and forest products. Changes in the exchange rates of the U.S. and Chinese currencies, or a significant increase or decrease in China's

overall economic growth rate, also would be likely to affect Chinese exports and overall consumption, with the effects rebounding onto commodities markets.

Another factor of concern is the domestic political situation in China. Media reports have emphasized the high level of political unrest among certain segments of the Chinese population. This situation has the potential to lead to economic disruptions which would decrease overall Chinese economic growth, and thus the country's demand for commodities. In contrast, government efforts to mitigate popular discontent might lead to increased demand in certain areas of the economy. Further analysis of changing demand scenarios related to the commodities in question, or to the Chinese economy more broadly, would prove useful.

This study looked closely at four specific commodity markets. However, concerns related to China's increasing demand extend across a broad range of commodities and raw materials. Further analysis of additional commodities would also be useful in informing the debate over the impact of Chinese demand on global commodity markets more broadly.

APPENDIX
ECONOMIC ANALYSIS OF THE EFFECTS OF CHINA'S INCREASE IN DEMAND ON GLOBAL COMMODITY PRICES

Economic Analysis of the Effects of China's Increase In Demand on Global Commodity Prices

As indicated in the preceding chapters, China's consumption of the four commodity products discussed in this study has increased markedly over the past decade. Overall, it appears that China's demand, on its own, may have led to increases in global prices for the commodities studied here. However, factors such as increased world-wide supply of these products (especially petroleum, wood products, and aluminum) and changes in demand in other markets may have amplified or dampened this impact. In this section we discuss what results from other economic studies suggest regarding the impact of growth in China's demand on global and U.S. prices for crude petroleum, aluminum, forest products, and ferrous scrap.

Although the existing literature does not directly measure the effect that growth in China's demand has on the market for any of the four commodities, it can provide insights useful in assessing the potential effect of the growth in demand. The availability of pertinent information varies across the commodities, thereby requiring different approaches for analyzing the impact that the increase in China's demand has on each commodity. For petroleum and aluminum we base our analysis on existing estimates of the price elasticity of supply, while for forest products we consider results from a general equilibrium model that already focuses on China. While differences in available information preclude an overarching methodology for this section, we can use these existing results to make some broad statements about each commodity.

Without allowing for offsetting changes in global production capacity, results of existing studies suggest that increases in China's demand (as measured by changes in Chinese consumption)[1] increased global prices of crude petroleum by 12 percent to 37 percent between 1995 and 2004, and increased global prices for unwrought aluminum by 8 percent to 52 percent over the same period. Existing studies of the forest products market that allow for increases in China's production capacity suggest that China's growing economy has not led to a substantial increase in world prices of forest products. The existing literature does not speak directly to the impact of Chinese growth on the market for ferrous scrap. Some points of consideration, however, are discussed below.

Overview of Commodity Market Research

In general, the direct impact of changes in China's demand on global commodity prices depends on how firms adjust the prices they charge in response to those changes. Increases in China's demand are passed along to firms through changes in the price of the good. Given the new demand and price information, firms then decide how much to supply. The

[1] China's consumption is not an exact measure of China's demand. Changes in consumption can be caused by factors other than changes in China's demand, such as changes in demand in other countries or changes in supply. For example, even if China's demand remains the same, China's consumption may fluctuate due to price changes caused by changes in production capacity or changes in shipments to other countries brought about by changes in demand in those countries.

relationship between the price firms charge and the quantity they wish to supply to the market is typically measured by the price elasticity of supply.[2] When a change in consumption takes place, the increased quantity is due to a change in supply (a shift of the supply curve), a change in demand (a shift of the demand curve), or changes in both. When looking at changes in consumption, if we assume that supply does not change while demand does, then the increase in price associated with the change in demand can be determined using the elasticity of supply. This is what we do below for petroleum and aluminum. Of course, it is not technically correct to assume that supply does not change. For the commodities discussed here, supply has changed as China and other countries have increased their capacity. The results of this type of analysis must be considered within the context of these limitations. Allowing for the appropriate increases in supply would dampen the price effects estimated here.

To perform this analysis, we need estimates of the elasticity of supply for the relevant commodity markets. Several papers use empirical models to estimate the price elasticity of supply to the U.S. market for these commodities. Examples include Krichene (2005) for crude oil, and Boyd, Yung, and Seldon (1995) for aluminum.

As an alternative to analyses focused on estimating elasticities, other papers employ simulation models to study various issues pertaining to the commodity markets which are the subject of this study. These include commodity-specific simulation models such as the U.S. Regional Ferrous Scrap Model in Gruver and Giarratani (2005) and the Global Forest Products Model in Turner, Buongiorno, Zhu, and Prestemon (2003). Other papers use economy-wide simulation models to estimate the impact of changes in China's demand. Examples include Gan (2004) for lumber, and Fairhead and Ahammad (2005) and Spatafora, Yang, and Feyzioglu (2004) for aluminum. These studies allow for changes in both demand and supply for the commodities discussed here but do not directly address the question of how China's increasing demand affects global prices. While the results of these studies may not allow us a precise method for estimating the effect that the growth in China's demand has on commodity prices, they do provide some indication of what the impact might be.

In addition to affecting the price of the commodity in question, changes in China's demand may indirectly influence prices of upstream, downstream, and substitute products. Demand effects on the good itself, as well as on related goods are typically measured either by empirical models which directly estimate the impact on a modest number of specific products, or simulation models which are based on estimates from other empirical models or qualitative analysis. Papers that estimate the impact of changes in demand for commodities on the prices of downstream or related products include Grasso and Manera (2005), Duffy-Deno (1996), Borenstein et al. (1997), Balke et al. (1998), Shin (1994), and Gately and Huntington (2002) which all estimate the impact of changes in the price of crude petroleum on the demand for gasoline. The results of such studies are cited when discussing the broader impact of an increase in China's demand for crude petroleum.
With these general approaches in mind, we now turn to a discussion of the individual commodities that are the focus of this study.

[2] Typically, the price elasticity of supply is measured by the percentage change in quantity supply in response to a 1 percent change in price. For example, an elasticity of 0.25 indicates that a 10 percent increase in price will lead to a 2.5 percent increase in quantity supplied. Calculation of the price elasticity of supply assumes a competitive market.

Results of existing studies suggest that, holding all else constant, an increase in China's demand can have an effect on global prices of crude petroleum. Estimates of the price elasticity of supply found in the literature suggest that increases in China's demand (as measured by changes in Chinese consumption) increased global prices of crude petroleum by 12 percent to 37 percent between 1995 and 2004. In addition, projections for China's demand suggest an additional increase in price attributable to Chinese growth of anywhere from 4 percent to 20 percent by 2010. These estimates, however, ignore all supply increases that have taken place in the last ten years as well as those that are projected to take place over the next five years.[3]

As discussed in Chapter 2 of this report, China's demand for crude petroleum has risen substantially over the past decade and is expected to continue increasing over the coming decades. This shift in demand has potential implications not only for the petroleum market, but also for the markets for related products such as gasoline and natural gas. There is a considerable body of literature that estimates changes in China's demand. However, these studies, along with more general studies of the petroleum industry as a whole, provide only limited insight into the potential broader impact of the increase in China's demand.

Bustelo (2005) provides a brief summary of the results of a number of studies that predict growth in China's demand for oil. Reported Chinese consumption was 6.4 million barrels per day (b/d) in 2004, which accounted for 7.8 percent of the 82.8 million b/d consumed worldwide.[4] Estimates for Chinese consumption in 2010 in the studies surveyed by Bustelo (2005) ranged from 7.1 million b/d to 10.6 million b/d, while predictions for 2020 range from 8.8 million b/d to 12.8 million b/d.[5] These predictions suggest that China will account for anywhere between 7.5 and 11.2 percent of worldwide consumption by 2010, and anywhere between 7.9 and 11.5 percent of worldwide consumption by 2020.[6]

Estimates for the price elasticity of supply for crude oil indicate that in the short run, unexpected increases, or shifts, in China's demand would cause a large increase in world prices as the quantity supplied will be unable to adjust quickly. Estimates also suggest that in the long run, while quantity supplied will have more time to adjust, increases in China's demand may nevertheless lead to substantial price increases. These conclusions are based on the elasticities estimated by Krichene (2005). Krichene uses a simultaneous equations model for crude oil and natural gas to estimate both *short run* and *long run* price elasticities of supply and demand for oil during three periods: pre-oil crisis (1918-1973), post-crisis (1974-2004), and both periods combined (1918-2004). Estimating the model using two distinct methods of estimation, the author finds that the *short run* price elasticity of supply is quite small in the post-crisis period (-0.05 or -0.03), implying that supply will not respond significantly to *short run* price increases.[7] Krichene also estimates the *long run* price elasticity of supply for the same periods using two different estimation techniques. A *long*

[3] See chapter 2 for a detailed discussion of factors affecting supply both in China and worldwide.

[4] U.S. Department of Energy, *International Energy Annual 2003.*

[5] Bustelo, "China and the Geopolitics of Oil in the Asian Pacific Region," 15.

[6] These shares are based on predictions of worldwide consumption of oil growing to 94.6 b/d by 2010, and 111b/d by 2020. Energy Information Agency, *International Energy Outlook,* 2005 (reference case).

[7] Since supply elasticities are normally positive, a small, negative result is consistent with a perfectly inelastic *short-run* supply curve, indicating that suppliers do not have the ability to increase supply in the short run.

run elasticity measures the final and long-term change in quantity supplied in response to a change in price. As expected, supply is found to be more elastic in the long run with an elasticity of 0.23 or 0.25 (depending on the estimation technique used) in the post-crisis period. This result suggests that a long run price increase will generate significant supply increases through increased oil exploration and investment.

Conscious of the limitations of basing estimates on the results of only one study, we can use Krichene's long-run elasticity estimates to approximate how an increase in China's demand may affect world prices. Assuming a long-run price elasticity of supply of 0.25[8] and assuming that demand in other countries as well as global supply remain constant, the increase in China's demand (as measured by changes in Chinese consumption) suggests an increase in global prices of crude petroleum by 18 percent between 1995 and 2004.[9] Accounting for the statistical uncertainty of Krichene's elasticity estimate, this increase ranges from 12 percent to 37 percent with 95 percent confidence during the same period.[10] While these numbers may seem large, it is important to remember that oil prices have risen by 200 percent over this period. If a 12 percent to 37 percent increase in the price of oil is due to growth in China, then the remaining increase of 163 percent to 188 percent is due to other factors.

Looking toward the future, a 0.9 million b/d increase in Chinese consumption of oil by 2010 (as predicted by Crompton and Wu (2005), one of the papers cited by Bustelo (2005)) is consistent with a total global price increase of about 4.3 percent from 2005 and 2010. When the analysis is expanded to include the entire range of China's demand projections presented in Bustelo (2005) (which range in growth of consumption from 0.7 million b/d to 4.2 million b/d), a supply elasticity of 0.25 is consistent with price increases ranging from 3.4 percent to 20.3 percent over the same period.

As alluded to in the introduction to this chapter, these estimates rely on several strong assumptions. First, they assume the price elasticity of supply is accurate and constant over the size of the price increase. Second they assume that global supply (both inside and outside of China) and demand outside of China do not change; in reality both are changing constantly. As detailed in chapter 2 above, China and the other oil producing countries are continuously involved in efforts aimed at increasing global supply, while at the same time stemming the increase in demand. It is also important to keep in mind that petroleum markets operate in an environment significantly influenced by OPEC, which has at least some power to influence the price or supply of petroleum. In addition, political turmoil and other unexpected events in oil producing countries may influence the market in unforeseen ways and limit the ability to predict future behavior of the oil market. These concerns notwithstanding, the elasticity exercise performed above provides a rough estimate of the extent to which China's demand increases likely affect the world market, holding all other factors constant. However, given the other factors that also simultaneously affect the global petroleum market, it is not possible to directly link the price increases witnessed during 2005-06 to rising Chinese demand for petroleum.

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[8] This is the higher estimate for Krichene's *long-run* price elasticity of supply. It indicates that a 10 percent rise in oil prices will precipitate a 2.5 percent increase in oil production, all else being equal.

[9] Based on 2004 global consumption of 82.8 million b/d and using an arc-elasticity.

[10] A similar analysis that incorporates the observed change in global prices as well as an estimate of the elasticity of demand for petroleum and the rest of the world suggests that growth in China's demand is responsible for a price increase of between 11 and 18 percent from 1995 to 2004.

While, all else being equal, increased demand for petroleum will lead to increased price of petroleum, it is important to consider potential secondary effects that may arise as a result of Chinese growth. Griffin and Schulman (2005) suggest that increases in oil prices may spur technological change (primarily in the United States and other developed countries) that reduces worldwide demand for oil. Such a secondary effect in industrial countries, which currently account for the lion's share of global demand for petroleum, will likely soften the impact on global oil prices of the increase in China's demand.[11] Griffin and Schulman (2005) indicate that as energy or oil prices increase, new technology is developed to make more efficient use of energy, and then, as prices fall again, consumers using the new technology need less energy and therefore do not respond as strongly in their consumption patterns. This technological change, they argue, helps to explain the existence of the asymmetric relationship often found in oil prices, with consumers responding strongly to significant increases in oil prices and not as strongly to decreases in the price. Such a result has been found by a number of researchers. Most notably, using data from 96 countries, Gately and Huntington (2002) find that oil demand (and energy demand in general) respond asymmetrically to price changes with the largest response occurring when prices hit new highs.

Changes in crude oil prices resulting from changes in China's demand may also affect prices of downstream products such as gasoline, which accounts for about half of all U.S. consumption of petroleum products.[12] However, while it is clear that increases in the price of crude petroleum lead to similar increases in the price of gasoline,[13] the evidence is mixed as to whether decreases in the price of crude lead to equally large decreases in the price of gasoline, and whether markets adjust as quickly to price decreases as they do to price increases. While Borenstein et al. (1997) find evidence that gasoline prices will follow crude prices up but will become sticky on the way down, Balke et al. (1998) produces mixed results that depend on the specification, and Shin (1994) finds no evidence of price asymmetry.

Changes in China's overall demand for energy may also indirectly affect prices of other energy sources such as natural gas and coal. China has abundant domestic coal supplies and is expected to begin importing natural gas by 2010.[14] Estimating a simultaneous equations model for the oil and natural gas markets, Krichene (2005) finds that the supply of natural gas increases with the supply of oil - both in the short run and long run. Prices are even more closely related since, as pointed out by Foss (2005), most liquified natural gas contracts are based on oil prices.[15] The prices of oil and natural gas have been converging due to the ability to switch between the fuels in many end uses.[16] So while the natural gas market will certainly be affected by China's demand for natural gas, it will also be affected by China's growing demand for oil.

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[11] An example of this theory in action can be seen in the increased popularity of hybrid and highly fuel-efficient cars.

[12] Balke, Brown, and Yucel, "Crude Oil and Gasoline Prices," 2.

[13] Long-run estimates of the price pass-through between crude oil and retail gasoline prices range from 81 percent (Borenstein, Cameron, and Gilbert, "Do Gasoline Prices Respond Asymmetrically to Crude Oil Price Changes?") to 100 percent (see Duffy-Deno, "Retail Price Asymmetries in Local Gasoline Markets" for a summary of earlier results).

[14] Bustelo, "China and the Geopolitics of Oil in the Asian Pacific Region," 8.

[15] Foss, "Global Natural Gas Issues and Challenges," 125.

[16] Ibid. 125.

Aluminum

Price elasticities of supply estimated in the literature suggest that increases in China's demand (as measured by changes in Chinese consumption) increased global prices of unwrought aluminum by 8 percent to 52 percent during the period 1995 and 2004 and may be expected to cause a further increase of between 6 percent and 36 percent by 2010. These estimates, however, take only China's demand growth into account and ignore large increases in the supply of unwrought aluminum, especially from China, and changes in demand from other countries. In fact, when considering only unwrought aluminum, the impact of growth in both Chinese consumption and production taken together on the global market is not clear. However, higher Chinese demand for alumina and aluminum scrap causes prices for these inputs to increase, which will, in turn, cause aluminum prices to increase, thus affecting downstream consumers worldwide. Given the sparse data and the lack of existing literature to address this issue specifically, measuring the size of that effect is challenging.

Consumption of aluminum in China has increased by an average of 206 percent per year since 1995 and China was the world's largest aluminum consumer in 2004, with total consumption of 5.9 million metric tons. Growth in Chinese production of aluminum, however, has more than kept pace with its growth in consumption. Chinese production of aluminum nearly doubled between 2001 and 2004 and stood at 6.8 million metric tons in 2004 while consumption rose by 40 percent over that same period. This growth put a great deal of pressure on China's upstream capacity (specifically China's electric power generation) and led to the imposition of several measures to curtail growth in the aluminum smelting industry.[17] Nevertheless, both production and consumption of unwrought aluminum in China are expected to continue to rise, albeit at a much slower pace than exhibited over the past several years.[18]

The global price of unwrought aluminum is determined by trading at the London Metals Exchange (LME). Due to the centralized trading of aluminum, the market for aluminum, like that for petroleum, is truly global in nature, so that any changes in global consumption and production will have an effect on worldwide prices.

The price elasticity of supply in the aluminum industry can give us an idea of how an increase in China's demand will affect global prices. Using data from 1965 to 1988, Boyd et al. (1995) estimate price elasticity of supply of 1.39 for the U.S. aluminum industry. According to this estimate, supply is fairly elastic and a relatively small increase in price will be sufficient to induce a larger increase in production. Assuming that this elasticity applies not only to the United States, but also to aluminum production around the world, the estimate suggests that, taken on its own, the increase in China's demand (as measured by the change in Chinese consumption) increased global prices of unwrought aluminum by 14 percent during the period 1995 to 2004. Accounting for the statistical uncertainty in the econometric analysis used to estimate this elasticity, the impact lies between 8 percent and 52 percent with 95 percent confidence during the same period. Applying the same logic, an additional increase in Chinese consumption of 4 million metric tons by 2010, assuming no concurrent

[17] Fairhead and Ahammad, "China's Future Growth: Implications for Selected Australian Industries," 7.

[18] Datamonitor predicts an average annual growth rate of 6.3 percent for the period 2004–2009 as opposed to a rate of 21.5 percent in the period 2000–2004. Source: Aluminum in China: Industry Profile, Datamonitor, July 2005.

shifts in the supply curve (caused, for example, by increases in capacity), would be consistent with a price increase of between 6 percent and 36 percent.

While by itself, an increase in China's demand for aluminum would likely lead to higher prices worldwide, the impact has been dampened by ongoing growth in Chinese aluminum capacity and production, which, on its own, would lead to lower prices. Without accurate information regarding the relative sizes of the competing effects of higher production and higher consumption, it is difficult to determine the overall effect that the Chinese aluminum market has on global aluminum prices. It is entirely possible, for example, that China's booming aluminum production could result in a decrease in prices worldwide. While the direct effect of China's growth on aluminum prices may be uncertain, there is another, indirect effect that may influence global prices of aluminum. Specifically, China's effect on the world aluminum markets is likely to flow principally through its growing demand for aluminum inputs, rather than its demand for aluminum itself.

As discussed in Chapter 3, while China produces more aluminum than it consumes, it relies heavily on imports of alumina and aluminum scrap to support domestic production. This issue is addressed by Fairhead and Ahammad (2005) who study the potential impact of China's growth on five Australian industries including aluminum, using a dynamic general equilibrium model of the world economy. Under two scenarios regarding the pace of Chinese economic growth, they find that the primary impact of China's growth on the Australian aluminum market is transmitted through increased Chinese imports of alumina. This is also true for the rest of the world since China's demand for imported alumina appears to be the primary channel through which the growth of the Chinese aluminum industry has affected global aluminum prices. Fairhead and Ahammad (2005) report that Chinese net imports of alumina tripled between 2000 and 2004.[19] China has also increased imports of aluminum scrap, which can be melted down to make new aluminum.

Because of the central role that primary inputs play in China's impact on global aluminum markets, it is important to consider how changes in prices of these raw materials affect production, as well as global prices, of aluminum. Lindquist (1995) finds that raw materials are relatively price-inelastic in the Norwegian aluminum industry with price elasticity of demand estimates ranging from -0.11 to -0.17. This means that usage of these inputs in aluminum production falls only slightly with increases in the prices of the inputs. As a result, the cost of producing aluminum will increase with any increase in raw material costs. While this study uses data only for the Norwegian industry, production methods for aluminum are fairly similar worldwide, and these results are likely to apply to aluminum industries outside of Norway as well.

[19] Fairhead and Ahammad, "China's Future Growth: Implications for Selected Australian Industries," 7.

Forest Products

Results from existing studies that allow for increases in production capacity are consistent with the finding in Chapter 4 that growth in China's demand for forest products has not been responsible for a substantial increase in world prices. Also, projections for future prices of forest products show little or no increase provided that global production capacity is allowed to reach expected levels.

Gan (2004) uses a general equilibrium model to estimate the effect on global forest product markets of China's accession to the WTO. His results indicate that China's WTO accession will lead to a rise in the global price for forestry products/services[20] of 0.04 percent, and a decrease in global prices for lumber and wood products[21] of 0.1 percent, while drawing in imports of forestry and lumber products primarily from nearby Asian countries as well as imports of pulp and paper products from Asia, North America, and Europe. While Gan's study does not directly discuss the impact of Chinese growth, it does speak to the impact that increased trade with China has on the market for forest products.

Turner, Buongiorno, Zhu, and Prestemon (2003) use the Global Forest Products Model to make predictions concerning international demand, supply, trade, and prices, conditional on the last RPA (Resources Planning Act) Timber Assessment for the United States. They predict that by 2030, China will be the largest importer of forest products included in the model. They indicate that both the price and volume of U.S. exports of all forest product commodities except for sawnwood will increase between 1999 and 2030. They also indicate that substantial predicted growth in the value of U.S. paper exports (from $6.3 billion in 1999 to $24.7 billion in 2030) is most likely due to predicted strong growth in real paper prices, driven by rapid growth in China's demand for paper. However, while this model does allow for some changes in Chinese paper making capacity, it does not appear to allow for the "ample additions" to global and Chinese capacity discussed in Chapter 4, which would greatly dampen any increase in U.S. paper exports or growth in real paper prices. More recent projections by the same authors show little or no increase in paper or other forest product prices when production capacity is allowed to reach the levels now expected by the authors.[22]

Unlike the market for petroleum, the market for forest products, while global in nature, is characterized by regional differences that affect production and consumption. These differences are reflected in a wide variation in estimated region-specific price elasticities of supply.[23] Such a wide range makes it difficult to use these elasticities to analyze China's impact on global markets.

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[20] The forestry sector includes forestry services, timber tracts, logging, and forest nurseries and gathering of forest products.

[21] The lumber and wood products sector includes lumber, wood panels, wood containers, and wood buildings.

[22] Correspondence with Turner, Buongiorno, Zhu, and Prestemon regarding forthcoming research.

[23] For example, in a paper that uses the Global Forest Products model mentioned above, Zhu, Buongiorno, and Brooks (2002) assume that the price elasticity of supply for roundwood is 0.8. Kaillo, Moiseyev, and Solberg (2003) assume that the price elasticity of supply for timber is 0.5 for the EU-15, 1.2 for Russia, and 1.0 for all other regions based on previous econometric studies. Adams and Haynes (1996) estimate hardwood supply elasticities of 0.189 in the north-central region of the United States, 0.244 in the northeast region, 0.813 in the south-central region, and 1.011 in the southeast region.

Also, any impact on the global market for forest products from changes in China's demand will be limited by the degree of substitutability between forest products produced in China and other countries. Gan (2006) finds that in the U.S. market, domestic and imported softwood lumber are far from perfect substitutes, but that the degree of substitutability is higher in the long run, varies across products and, in general, has increased over time.[24] In addition, the high level of competition between goods produced from forest products in China and other countries suggests that forest products from different countries are highly substitutable.

Ferrous Scrap

While China's imports of ferrous scrap have increased quickly over the past decade, it is not clear from existing research how much of the observed increase in global prices is due to the increase in Chinese demand.

Similar to aluminum, an important issue when analyzing China's impact on the steel industry is China's demand for primary inputs - in this case ferrous scrap. Many attribute the unprecedented increase in ferrous scrap prices to China's rapidly growing steel industry. The anecdotal evidence is clear; China's imports of ferrous scrap have grown by over 200 percent since 1999 and the price of ferrous scrap in the United States has increased by 100 percent since January 2000 and over 240 percent since January of 2002.[25]

While prices are rising world wide, transportation costs may dampen the impact of China's demand for ferrous scrap on the U.S. market and create regional price variation similar to those for lumber. As noted above, petroleum and aluminum are less affected by such variation. The impact of transportation costs within the United States is modeled by Gruver and Giarratani (2005). These authors developed a model to study regional variation and interregional trade links between hundreds of individual scrap markets within the United States.[26] While the model allows for demand shocks from abroad, using it to estimate the impact of changes in China's demand on U.S. markets would require incorporating new estimates of regional supply and demand, and new transportation cost parameters.[27] However, if regional differences matter within the United States as much as their analysis indicates, then we can expect them to matter between the U.S. and Chinese scrap markets as well, particularly given the high inland transportation costs involved in shipping ferrous scrap to and from ports.[28]

Finally, while imports of ferrous scrap into China have been growing quickly for the past decade, the large increase in global scrap prices is a relatively recent phenomenon. And although the rate of growth in China's demand increased over the past few years, it is not clear how much of the recent increase in global scrap prices is due to this increased demand. In addition, the fact that the increase in demand for ferrous scrap by U.S. scrap-based mills

[24] Gan, "Substitutability between U.S. Domestic and Imported Forest Products."

[25] Based on ferrous scrap: No. 1 Heavy Melting Steel, Chicago consumer prices, January 2000–October 2005. Source: Compiled by USITC staff from statistics of American Metal Markets.

[26] The U.S. Regional Ferrous Scrap Model characterizes regional variation in prices for two grades of ferrous scrap, in 1,212 supply and 240 demand regions using data from 1989.

[27] Much of the discussion in this and the following paragraph is based on correspondence with the authors of the model, Gene Gruver and Frank Giarratani, and their colleague Soiliou Namoro.

[28] Low overseas shipping costs reduce the regional variation attributable to trans-oceanic shipping of ferrous scrap.

after 1989 coincided with the increase in China's demand makes it difficult to separately identify the impacts of increased China's demand and increases in demand by U.S. scrap-based mills using available data.

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