THE MARKET & COST ENVIRONMENTS FOR BULK FERROALLOYS

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ABSTRACT

This paper discusses the worldwide market and cost environments for the bulk ferroalloys namely manganese alloys (ferromanganese, silicomanganese), ferrosilicon and ferrochrome (high-carbon ferrochrome, charge chrome).

Annual average market prices since 1993 are presented graphically and analysed, and the main supply and demand trends for manganese, ferrosilicon and ferrochrome are summarized. The paper shows carbon and stainless steel output data for 1995, 2000 and 2005, mainly to demonstrate the rising importance of China as a ferroalloys market.

Developments in ferroalloys capacity worldwide from 1991 to 2007 are discussed (plant start-ups and closures, ownership changes).

Finally, the paper examines developments in the main cost factors for the bulk ferroalloys, i.e., chrome and manganese ore, electricity, carbon reductants and labour.

Note that data for 2006 are estimated based on information available in November 2006.

1. PRICES

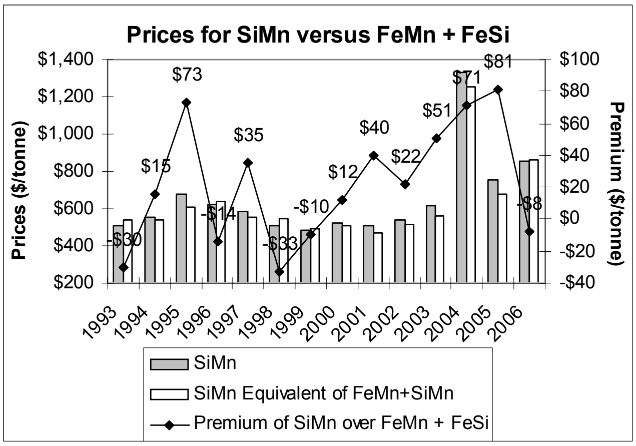
The table shows average annual prices for the US market for high-carbon ferrochrome, high-carbon ferromanganese, silicomanganese and ferrosilicon, in both "nominal" and "real" (i.e. adjusted for inflation) terms. The calculations demonstrate that high-carbon ferrochrome and ferrosilicon prices decreased in real terms by an average of 0.2% and 2.4% per year respectively from 1993 to 2005.

Manganese alloy prices, on the other hand, increased in real terms over the same period: high-carbon ferromanganese by 2.8% per year, and silicomanganese by 2.3% per year. This calculation was unduly influenced by the extraordinary price levels for manganese alloys experienced during 2004: from 1993 to 2003 prices for manganese alloys decreased by an average 0.5% per year.

Table 1: Ferroalloy prices from 1993 to 2005 on a "nominal" and "real" basis

	PPI (Annual Average)	*HC FeCr (c/lb)*		*HC FeMn ($/tonne)*		*SiMn ($/tonne)*		*FeSi ($/tonne)*	
		Nominal	*Real*	*Nominal*	*Real*	*Nominal*	*Real*	*Nominal*	*Real*
1993	124.7	37.1	47.2	$484	$616	$507	$645	$666	$848
1996	131.3	43.8	53.0	$522	$631	$624	$756	$1,019	$1,232
1999	133.0	35.6	42.5	$437	$522	$486	$579	$657	$783
2002	138.9	30.6	35.0	$487	$556	$538	$615	$552	$630
2005	155.7	66.9	68.3	$623	$637	$758	$773	$782	$799
% Average Annual Change		**1.7%**	**-0.2%**	**4.7%**	**2.8%**	**4.1%**	**2.3%**	**-0.7%**	**-2.4%**

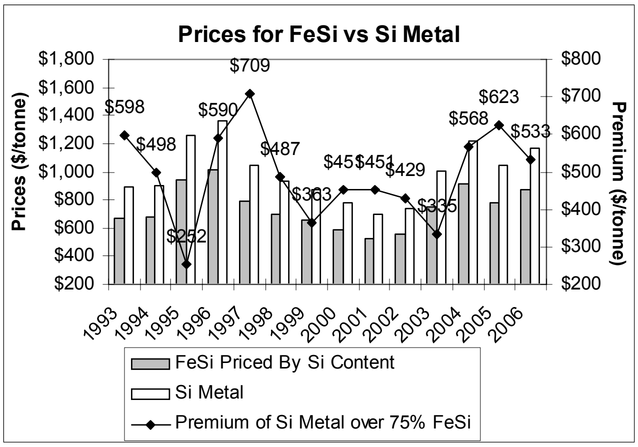
("Nominal" monthly prices were converted to "real" using PPI series WPUSOP3000 from the US Department of Labor. The base month was December 2005.)



The chart contrasts annual average prices for silicomanganese versus those for the "silicomanganese equivalent" of using ferromanganese plus ferrosilicon (see note below). It shows an increasing price premium for silicomanganese since the late 1990s, reaching $81/tonne in 2005.

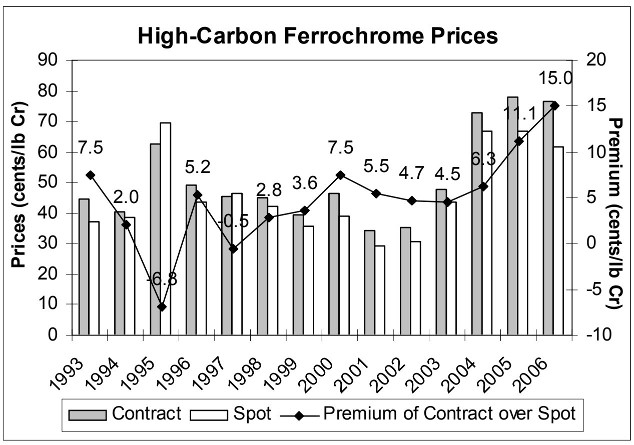
Silicomanganese Equivalent Price = 65/78 x Ferromanganese Price + 15/75 x Ferrosilicon Price.

Figure 1: Manganese Alloy & Ferrosilicon Price Comparison



Shown are annual average US prices for ferrosilicon (on a per tonne of silicon metal contained) versus silicon metal. It shows that the price premium of silicon metal over ferrosilicon rose to $623/tonne in 2005, the highest level since 1997.

Figure 2: Ferrosilicon & Silicon Metal Price Comparison

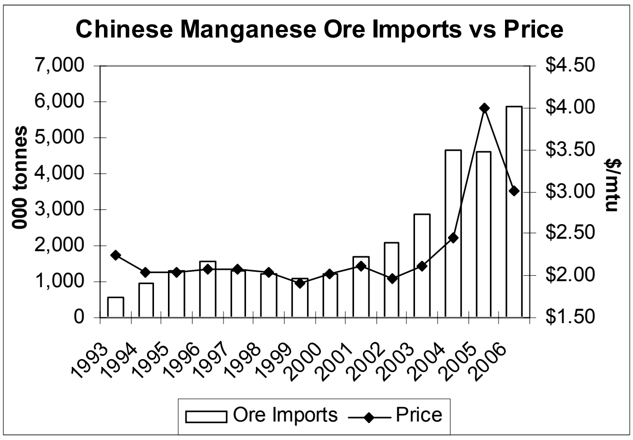


Annual average contract (nominal value) and spot prices for high-carbon ferrochrome are shown. The chart shows that the discount of market from nominal contract prices widened to 11c/lb in 2005 against a typical level of between four and six cents per lb in the preceding years.

Figure 3: Contract & Spot Prices for High-Carbon Ferrochrome

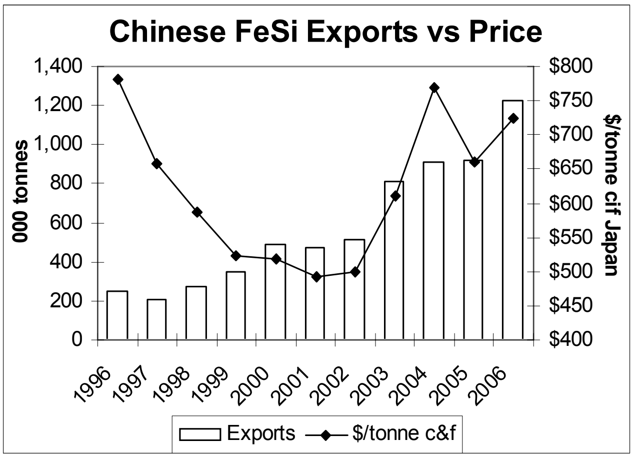
2. SUPPLY & DEMAND

Alloy	*Main Trends*
Manganese Alloys	Due to the rapid growth in its steel production, China has become the most important market for manganese. To date, it has imported ore rather than alloys. It remains a sizeable exporter of manganese alloys, although the government is discouraging conversion agreements for reasons of environmental protection. The Nikopol plant in Ukraine is an important factor in the world market due to its sizeable capacity of 1.3m tpy. In 2005-2006, the government attempted to re-nationalize the plant. A dispute between the majority owner Interpipe and the minority shareholder Privat Intertrading has disrupted production over the past few years, and played a role in the tight market. Much of the capacity in mainland Europe has closed over the past two decades, with Eramet's Boulogne plant closing in 2003. In Norway, the manganese alloy plants are increasingly focusing on special grades. A limited number of global mineral resource groups continue their hold on high-grade manganese ore reserves, though in South Africa "black economic empowerment" initiatives may lead to new market entrants in the next few years. It is noticeable that the ore producers have generally been reluctant to invest in manganese alloys capacity over the past decade or so.
Ferrosilicon	Producers in Europe and North America have largely switched production from commodity grades of ferrosilicon to special grades for electrical steel and foundry markets, as well as to silicon metal. This has even been the case in Norway, from a historical perspective Europe's largest and lowest cost producer of ferroalloys. Brazilian producers are moving capacity from ferrosilicon to silicon metal. China has become a major supplier of commodity 75% ferrosilicon to world markets, its exports increasing to more than 0.9m tonnes in 2004 and 2005. Aided by low energy costs, Russia and Ukraine are also important suppliers to world markets.
Ferrochrome	South African charge chrome capacity has grown from around 1.8m tpy in 1995 to 3.5m tpy in 2005. Over the same period, much of the non ore integrated ferrochrome capacity in Europe and Japan has closed down. The value of the South African rand has become a major factor in the ferrochrome market. This volatile currency moved from an undervalued position of R10.5/US$ average in 2002 to R6.4/US$ in 2005. The strong rand played a major role in prices averaging more than 60c/lb in both 2004 and 2005. Aided in part by a major devalulation of the Kazakh tenge and a stable management structure since 1999, Kazakhstan has increased production and exports by an average of more than 10% per year over this decade. Kazakhstan has become the second-most significant supplier of ferrochrome after South Africa, as well as the lowest-cost producer. India has low-cost and good-quality chrome ore but its high conversion costs means that it plays the role of a "swing" supplier, increasing its exports only when prices are higher than 60c/lb cif or so. China became a net importer of ferrochrome from 2002, and is emerging as an important market for Kazakhstan and South Africa. Short term, however, its chrome ore imports strongly outweigh ferrochrome imports.



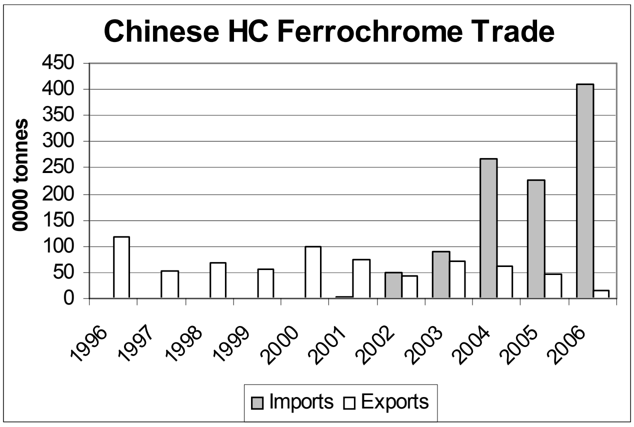
China's imports of manganese ore rose from around 1.6m tonnes in 1996 to 4.7m tonnes in 2004 to become the world's most important market. The high-grade manganese ore price increased from $2.45/mtu in 2004 to $3.99/mtu in 2005, but fell to $3.01/mtu in 2006. (mtu = metric tonne unit)

Figure 4: Chinese Manganese Ore Imports & Price



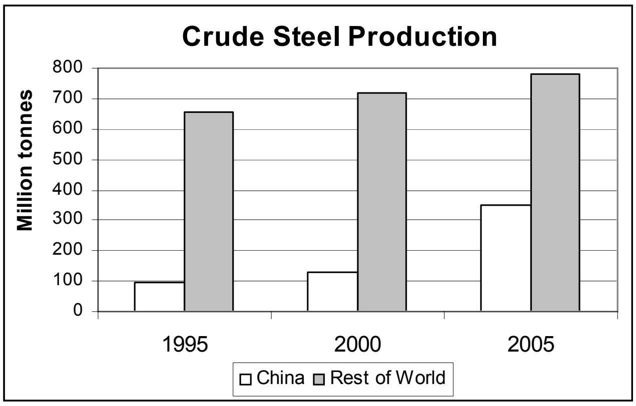
China has become the most important exporter of standard-grade ferrosilicon to world markets. Its exports increased from 250,000 tonnes in 1996 to more than 900,000 tonnes in 2004 and 2005. In 2006, exports are likely to have exceeded 1.2m tonnes.

Figure 5: Chinese Ferrosilicon Imports & Price



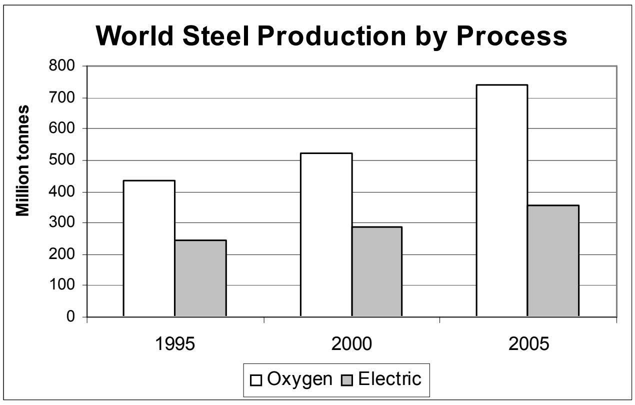
From 2002, China has been a net importer of high-carbon ferrochrome. Imports were 265,000 tonnes in 2004, but fell to 225,000 tonnes in 2005. In 2006, they are likely to have increased to more than 400,000 tonnes. China continues to export ferrochrome, produced from imported ore.

Figure 6: Chinese High-Carbon Ferrochrome Imports & Exports



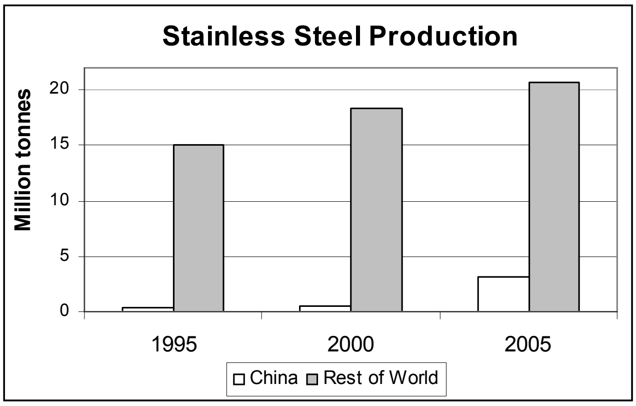
Crude steel production in China has seen by far the fastest growth of any country over the past decade, rising from less than 100m tonnes in 1995 to almost 350m tonnes in 2005. China now accounts for 30% of total world steel production. (Data from the International Iron & Steel Institute.)

Figure 7: Crude Steel Production in China & Rest of the World



The oxygen route still dominates steel production, despite expectations that the lower cost electric arc route would gain more share. Oxygen steelmaking accounted for 67% of the world total in 2005, compared to 64% in 1995 and 65% in 2000. (Data are from the International Iron & Steel Institute.)

Figure 8: Crude Steel Production by Process



China's production of stainless steel has assumed an increasing importance but accounts for less than 15% of the world total. Nevertheless, Chinese production grew five-fold between 2000 and 2005. (Data are from industry associations and Resource-Net estimates.)

Figure 9: Stainless Steel Production in China & Rest of the World

3. CAPACITY DEVELOPMENTS

The table below summarizes key industry developments in ferroalloys capacity since 1991:

World Ferroalloy Capacity Developments

Year	*Ferrochrome*	*Manganese Alloys*	*Ferrosilicon*
1991	Samancor acquires the Middelburg and Krugersdorp plants. Ferrochrome production stops at Hellenic Ferro Alloys in Greece. Tata acquires Orissa plant from OMC.	Ferromanganese plant SEAS opens at Dunkirk, France.	Ferrosilicon plant starts in Iran.
1992	Chromeurope in France and Fesa in Spain both stop ferrochrome production.	British Steel closes ferromanganese plant at Redcar, UK. Comilog acquires Dunkirk plant from Pechiney.	Timminco closes ferrosilicon plant in Ontario, Canada. The Spanish ferroalloy and energy business of Carburos Metallicos is sold to private investors and renamed "Ferroatlantica".
1993	Pacific Metals in Japan stops ferrochrome production.	Thyssen Stahl closes Duisburg ferromanganese plant in Germany. Sinai Manganese starts production of ferromanganese in Egypt. Elkem and BHP form manganese joint venture. Tung Chou in Taiwan closes. Ferroalloys producer in Indonesia, Inter Ferro Mangando, is set up. Grupo Ferrominero acquires Mexican ferroalloys producer Minera Autlan from the government.	Siltech starts ferrosilicon production at an idle calcium carbide plant in South Africa. Sibra begins silicon metal production in Bahia, Brazil.
1994	Indian Metals & Ferro Alloys (Imfa) stops ferrochrome production at Orissa plant.	Japanese ferromanganese producer, Yahagi Iron, closes down.	Elkem halts ferrosilicon production at its Ashtabula plant, USA. Ferbasa and JMC form joint venture to produce high-purity ferrosilicon for the Japanese market. Indsil Electrosmelt and Silcal Metallurgic begin ferrosilicon production in India's Kerala state.
1995	The Donskoy mine and the two ferroalloy plants in Kazakhstan are consolidated into "Kazchrome". Trading group Trans-World acquires management control of Kazakhstan's chrome industry via a share in Kazchrome. Ispat Alloys starts producing ferrochrome at its Balasore plant, Orissa.	Sibenik silicomanganese plant in Croatia closes. Brazilian producer Prometal shuts. Comilog forms joint venture in China with Shaoxing steelworks. BHP forms joint ventures in China with Emei and Liaoyang. CVRD and Usiminas take joint control of manganese alloy producers, Cia Paulista de Ferro Ligas in Minas Gerais and Sibra in Bahia. Abadan smelter starts up in Iran.	Ferrosilicon plant starts in Bhutan. JMC closes ferrosilicon plant at Minami-iwate, Japan. Globe Metallurgical acquires Niagara Falls silicon alloys plant from SKW.

World Ferroalloy Capacity Developments (Continued)

Year	*Ferrochrome*	*Manganese Alloys*	*Ferrosilicon*
1996	Hernic begins charge chrome production at Brits, South Africa. Chromecorp opens the Wonderkop plant. Philippine ferrochrome plants close.	Brazilian manganese alloys producer Cia Ferroligas do Amapa closes. Gulf Ferro Alloys (Sabayek) starts production in Saudi Arabia. Manganese alloys production begins at Navid Manganese in Iran.	Second ferrosilicon plant starts up in Iran. Ferrometals of South Africa stops ferrosilicon production.
1997	Nava Bharat starts ferrochrome production at Orissa, India.	Kazchrome acquires manganese ore deposit in Kazakhstan, leading to a major increase in output of manganese alloys at the Aksu plant.	Globe Metallurgical acquires 33% of Fesil's shares as well as Hafslund Metall. Walters Industries buys the Aimcor business, including its Bridgeport ferrosilicon plant, Alabama.
1998	Trans-World Group's involvement with the Kazakh chrome industry comes to an end, as its local partners cancel the joint-venture agreement. CMI's chrome assets acquired by Chromecorp (now Xstrata). Indian Metals & Ferro Alloys (Imfa) resumes ferrochrome production at Orissa plant. Closure of Darfo, the last remaining ferrochrome plant in Italy. Japan Metals & Chemicals stops ferroalloys production.	Feralloys of South Africa starts refined ferromanganese production in joint venture with Sumitomo Corp and Mizushima. Another refined manganese alloys plant "Advalloy" is opened by Samancor with Japanese partners. Elkem-BHP manganese joint venture is dissolved. Samancor acquires BHP manganese assets in Australia. Ferromanganese production at Pokoj in Poland stops.	Ferroatlantica acquires ferrosilicon plant Ferrosilven from Venezuelan government. Indel of Italy closes.
1999	A consortium known as "Millennium 2000" (later to become Eurasian Natural Resources) assumes control of Kazchrome, together with overseas sales arm "Alloy 2000". Chinese-managed ASA Metals opens plant at Dilokong mine, South Africa's Limpopo province. Maranatha starts ferrochrome production in Zimbabwe. Acesita in Brazil begins ferrochrome production for captive use. US plant Macalloy closes.	CVRD takes 100% control of Brazilian manganese alloy plants in Minas Gerais and Bahia. Elkem sells its manganese plants to Eramet. Sadaci plant in Belgium, part of Comilog, stops manganese alloys production. Grassi in Argentina stops production. Indian manganese alloys sector shifts capacity to West Bengal due to low power costs. Some capacity in Maharashtra, India's historical centre for manganese alloys, closes down. Romanian producer Ferom goes into bankruptcy.	Pechiney Electrometallurgie (PEM) and Samancor merge their silicon metal activities into an entity known as "Invensil".

World Ferroalloy Capacity Developments (Continued)

Year	*Ferrochrome*	*Manganese Alloys*	*Ferrosilicon*
2000	Albanian chrome assets are acquired by Darfo of Italy. Croatian ferroalloys producer Dalmacija closes permanently. Zimbabwe Alloys switches from low-carbon to high-carbon ferrochrome. Orissa reserves are re-distributed by court decision, widening access to chrome ore in India.	Elkem takes control of Bjoelvefossen. Comilog installs manganese ore sintering plant in Gabon. Rio Doce acquires 100% control of the SEAS plant in France.	Dow Corning acquires CBCC silicon alloys plant in Brazil. American Alloys ceases ferrosilicon production at New Haven.
2001	Samancor and Xstrata form "Gemini" joint venture at Wonderkop. Krugersdorp plant of Samancor closes, though re-opens later for occasional tolling arrangements. Tata first proposes the construction of a ferrochrome plant outside India, deciding on South Africa as the site.	Italian manganese alloy plants affiliated to Comilog close.	Elkem acquires Brazilian silicon metal producer Camargo Correa Metais. Macedonian ferrosilicon plant Jugohrom stops production. Production halts at Keokuk plant in the USA.
2002	SA Chrome, now Merafe Resources, completes plant at Boshoek. Mitsubishi Corporation takes controlling interest in Hernic Chrome. Elkem stops ferrochrome production at Rana. Kermas acquires control of Serov plant in Russia.	Privat Intertrading acquires the Zaporozhye manganese alloy and Stakhanov ferrosilicon plants in Ukraine, as well as the Romanian ferroalloys plant which becomes "Feral".	
2003	Japan's last volume ferrochrome plant, Shunan Denko, closes.	Closure of Eramet's Boulogne ferromanganese plant, France. CVRD acquires Rana plant and restarts for manganese alloys. Interpipe acquires majority control of the Nikopol ferroalloys plant, taking its total share to 74%; Privat Intertrading holds the remainder.	Elkem acquires majority control of Icelandic Alloys. Globe Metallurgical surrenders its share in Fesil as part of a legal settlement. Silicon alloys producer PEM comes under Alcan ownership. Oxbow Carbon & Minerals acquires Aimcor from Walter Industries. Macedonian ferrosilicon plant restarts under ownership of Silmak. Erdos begins ferrosilicon production from a large plant in Inner Mongolia, China.

World Ferroalloy Capacity Developments (Continued)

Year	*Ferrochrome*	*Manganese Alloys*	*Ferrosilicon*
2004	Merafe Resources and Xstrata merge their South African chrome interests. Turkish ferrochrome producer Etikrom is privatized. Kermas acquires Elektrowerk Weisweiler plant in Germany.	Sandur Manganese & Iron Ores sells its shuttered Maharashtra plant to Jindal Iron & Steel.	Timminco acquires Becancour silicon alloys plant in Canada. In Russia, Chelyabinsk plans to transfer all its ferrosilicon production to its affiliate Kuznetsk, following its acquisition in 2003. Italian group Metalleghe acquires Bosnian silicon smelter.
2005	South African producer Samancor Chrome acquired by Kermas, backed by Russian interests. In Orissa, Jindal opens the first stage of a major ferrochrome complex. Shanghai Shenjia ferrochrome plant closes, relocating production to the Chinese interior. Anglo American sells its Zimalloys smelter to private Zimbabwean investors.	Manganese alloys production halts in Romania. Mogale Alloys completes its purchase of the Palmiet plant, Krugersdorp. New government in Ukraine attempts to reverse the privatization of Nikopol of 2003.	Alcan sells PEM to Ferroatlantica of Spain. Orkla acquires 100% control of Elkem. Finnfjord ferrosilicon plant in the north of Norway stops production indefinitely.
2006	International Mineral Resources, a subsidiary of Eurasian Natural Resources, acquires minority shares in Samancor Chrome and Serov Ferroalloys from Kermas. Environmental objections to Tata's Richards Bay plant finally overturned. Xstrata starts up greenfield plant in Mpumalanga. Imfa group completes the first stage of major ferrochrome project in Orissa.	Nippon Denko closes its Hokkaido plant, relocating the production to China. Erdos in Inner Mongolia, China is to start producing silicomanganese.	JFE Steel acquires control of Nova Era Silicon, Brazil from CVRD. Alloy, West Virginia silicon alloys plant acquired by Globe Metallurgical from Elkem. Egyptian government to privatize Efaco ferrosilicon plant.
2007	International Ferro Metals to start production at Buffelsfontein. Tata Steel's Richards Bay plant is due to start production.		

4. COST FACTORS

Cost Factor	*Developments*
Ore	The use of unscreened ore has been largely eliminated by ferroalloy smelters over the last ten years, with a resultant improvement in overall yields. Ore agglomeration prior to reduction has become normal practice for ferrochrome and manganese alloys smelters, either pelletizing - better smelting properties than either lumps or briquettes but high capital cost - or briquetting - lower capital cost but inferior smelting characteristics as well as higher energy consumption. The use of pellets or briquettes has improved yields and also has the benefit of consuming fines, both ore and metallic, which would otherwise be sold off at a discount.

Cost Factor	*Developments*
	The use of UG2 chromite fines produced by platinum mines has reduced the costs for South African charge chrome plants since the late 1990s, but with a resultant reduction in the chrome grade and hence higher transportation costs per tonne of metal content. Whereas manganese ore prices are mostly settled annually, chrome ore is priced on a quarterly basis. In 2005 and 2006, ore prices were high compared to alloy prices compared to the two previous years (see charts on subsequent page). The supply of high-grade manganese ore has historically been more tightly controlled than that for chrome ore. However, the greater use of silicomanganese over ferromanganese, requiring lower grades of manganese ore, has weakened the position of the high-grade ore producers to some extent. Over the past five years or so, open-cast ore reserves have been largely mined out, resulting in a shift to underground mining with associated higher capital costs.
Reductants	For chrome and manganese alloys production, metallurgical coke is difficult to replace completely as a reductant. Ferrochrome requires between 0.6-0.65 tonnes of reductant per tonne, of which coke constitutes at least 50-60%, sometimes 100%. The reductant quantity for manganese alloys production by electric arc furnace is significantly lower than for ferrochrome at 0.4-0.45 tonnes, of which the coke portion can vary considerably. Chinese pricing has become the benchmark for the world coke market, 12/12.5% ash being the main export grade. Critical supply shortages for coke emerged during 2004, resulting in the price reaching more than $400/tonne for some weeks. In some countries, there exists local availability of low-cost partial substitutes for coke such as char, gas coke, anthracite, charcoal or low-phosphorous coking coal. In general terms, the coke ratio of the reductant blend increases with larger furnace sizes, obviously favoured due to their higher productivity. Closed furnaces cannot normally use coal in their blend due to the sulphur emissions, hence tend to have a higher coke ratio than open furnaces. There is ongoing interest in novel processes that use lower coke ratios, such "Premus" to be used in Xstrata's new charge chrome plant in Mpumalanga and "AlloyStream" developed by Kumba Resources for manganese alloys.
Electricity	Ferroalloys production is a power-intensive industry, with ferrosilicon consuming more than 8000 kWh/tonne, ferrochrome 3800-4200 kWh/tonne, silicomanganese 3800 kWh/tonne and ferromanganese 2200 kWh/tonne. While it was thought that deregulation and privatization of the electricity industry would ultimately lead to lower prices for consumers, this has not proved to be the case in Europe and the United States, the two regions where this process has probably gone the furthest. Rising oil and coal prices and the introduction of "green" taxes has led to prices rising over the past two years. High grid access fees have hindered the functioning of an effective free market. To remain competitive for commodity ferroalloy grades in Europe, smelters have to possess long-term contracts at low prices or preferably captive generation capacity. Even in Norway, with its concentration of hydro-electric capacity, production of standard 75% ferrosilicon is being phased out, in favour of special foundry grades and silicon metal. In developing countries, such as China and India, costs have remained high over the past decade due to higher demand for power from increasingly affluent populations - and the expectation that industry will subsidize the necessary investments.

Cost Factor	Developments
	Two important ferroalloy producing countries, Russia and South Africa, have abundant coal reserves leading to low electricity costs. Brazil has extensive hydro-electric capacity, so also benefits from lower than typical prices. Contracts linked to commodity prices and other low-price deals are generally out of favour. To minimize power costs, users must increasingly accept "interruptible" contracts. Seasonal price increases have been introduced in winter months in South Africa, as have been prevalent in Europe for many years. Due to the above-mentioned factors it is difficult to be too precise when discussing power costs of the ferroalloys industry, but a paper in 2006 [1] supplied the following estimates (presumably for 2005): India – 6.4c/kWh, China – 4.1c/kWh, Kazakhstan – 3.5c/kWh, Finland – 3.0c/kWh and South Africa – 2.3c/kWh. In Brazil, power prices for ferroalloys smelters are reportedly between 3.0c and 3.5c per kWh.
Labour	Comparing labour counts from plant to plant is complicated by the differing employment and contracting out policies of the producers around the world. However, our analysis indicates that in South African ferrochrome industry, the average tonnes of capacity per worker (including long-term contractors) increased from around 500 tonnes in 1995 to 700 tonnes ten years later. The improved efficiencies have been achieved through the elimination of the over-manning and inflexible employment practices of the apartheid era, as well as the introduction of new technologies and the greater scale of production. In less developed economies, such as India and Zimbabwe, the equivalent figure falls to 200-300 tonnes per man. In Europe, the figure rises to 1,000 tonnes per man or even higher. According to an International Labour Organization survey for 2001, average annual labour costs in the non-ferrous metals industry ranged in that year from $42,400 for Norway, $12,100 for Brazil, $2,300 for China, $1,900 for Kazakhstan down to $1,400 for India. Clearly, there is likely to be an inverse relationship between these labour costs and the tonnes of capacity per worker mentioned earlier…

5. CONCLUSIONS

Prices for ferroalloys have largely failed to keep pace with inflation over the past decade, although thanks to a major price spike in 2004, manganese alloys outperformed the index from 1993 to 2005. While ferrochrome almost matched the inflation index, ferrosilicon prices fell in the real terms over the period in question.

China has become, of course, the major influence on all the ferroalloy markets due to the high growth of its carbon and stainless steel output over the past five years. Carbon steel output in China has more than tripled over the last decade and accounted for 30% of the world total in 2005. Stainless steel output in China in 2005 accounted for just less than 15% of the world total, but this ratio is likely to grow significantly in the future.

There has been an increasing price premium for silicomanganese over the equivalent cost of using ferromanganese plus ferrosilicon since 2000, seemingly reflecting greater demand for this alloy by steelmakers. Over the past two decades, much of the capacity for manganese alloys in Europe has been phased out for cost and environmental reasons. China has become the major market for manganese ore, its imports growing almost three-fold from 1996 to 2004. Ukraine has emerged as the major supplier of manganese alloys to world markets, but an ownership dispute has disrupted production in the last few years.

Silicon metal prices have outperformed those for ferrosilicon, encouraging many smelters to convert capacity from one alloy to the other. Production of standard-grade 75% ferrosilicon has declined significantly over the past decade in Europe, North and South America and most other regions of the world, even in countries previously regarded as having low power costs such as Brazil and Norway. For standard 75% ferrosilicon, China has become the main supplier to world markets, its exports totalling more than 900,000 tonnes in 2004 and 2005.

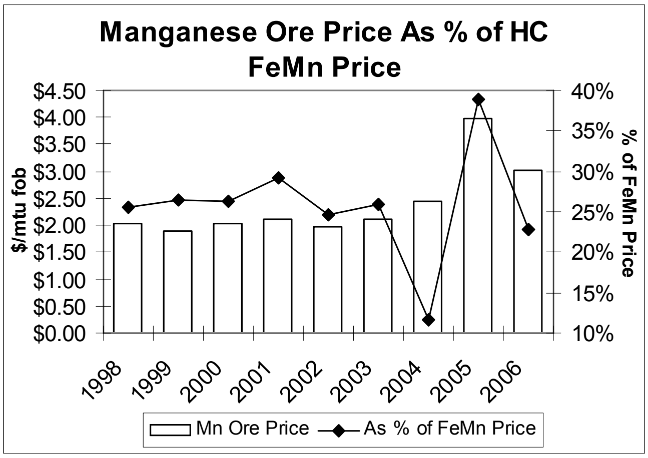


Figure 10: Comparison of Manganese Ore & High-Carbon Ferromanganese Prices

The chart shows high-grade manganese ore prices, settled annually, against the ore cost component of ferromanganese as percentage of the price. It shows that ore cost was consistently around 25-29% of the alloy price until 2004 when it fell to 12%, then increasing to 39% in 2005. In 2006, the ore-alloy price relationship "normalized".

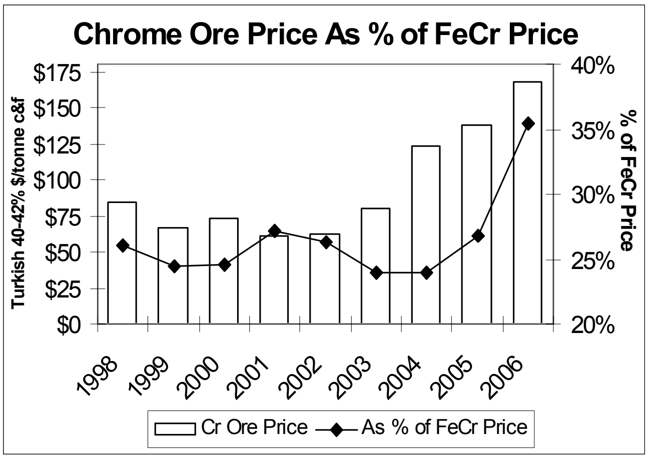


Figure 11: Comparison of Chrome Ore & High-Carbon Ferrochrome Prices

The same analysis is shown for chrome ore prices ($/tonne c&f China) and the ore cost component of high-carbon ferrochrome. The chrome ore cost component has varied between 24% and 27%. In 2006, this ratio increased to 35%.

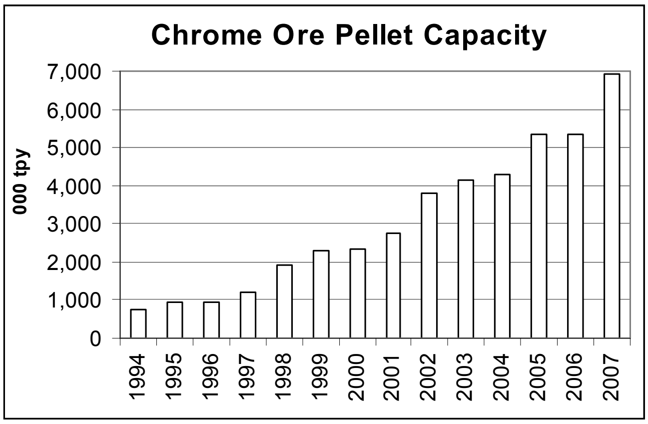


Figure 12: Chrome Ore Pellet Capacity

The same analysis is shown for chrome ore prices ($/tonne c&f China) and the ore cost component of high-carbon ferrochrome. The chrome ore cost component has varied between 24% and 27%. In 2006, this ratio increased to 35%.

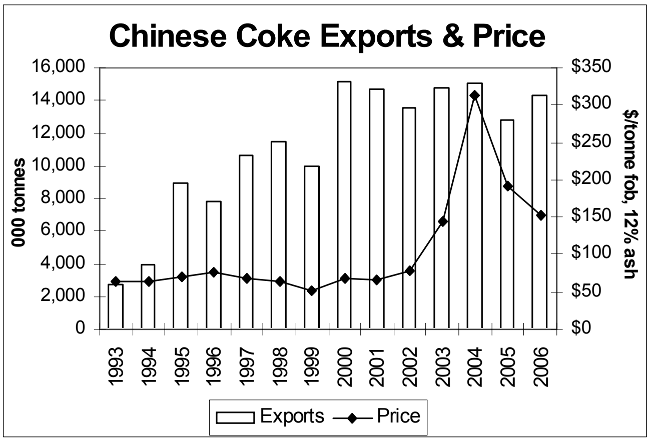


Figure 13: Chinese Coke Exports & Price

The chart shows annual average coke prices on a "fob China basis" versus Chinese coke exports. Prices escalated to an average of more than $300/tonne fob in 2004, almost five times the pre-2003 average. This was as a result of the maturation in the quantity of Chinese exports after 2000 and continuing high demand for merchant coke in the rest of the world.

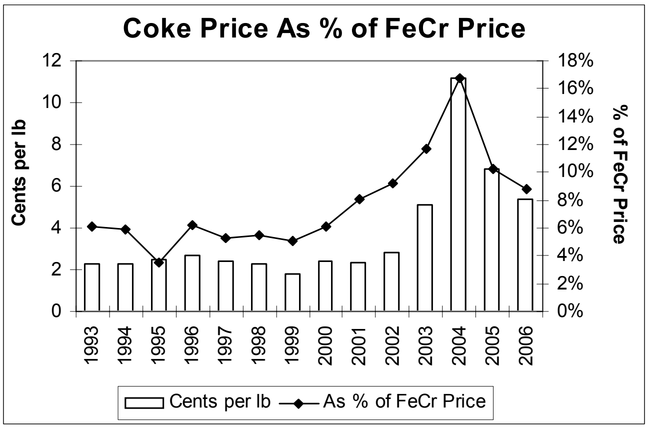


Figure 14: Coke Price As % of Ferrochrome Price

As a percentage of the ferrochrome price, the assessed coke cost increased from a typical level of 5-6% before 2000 to more than 10% in 2003-2005. It peaked at 17% in 2004, accounting for 11c/lb of the ferrochrome price, according to our assessment.

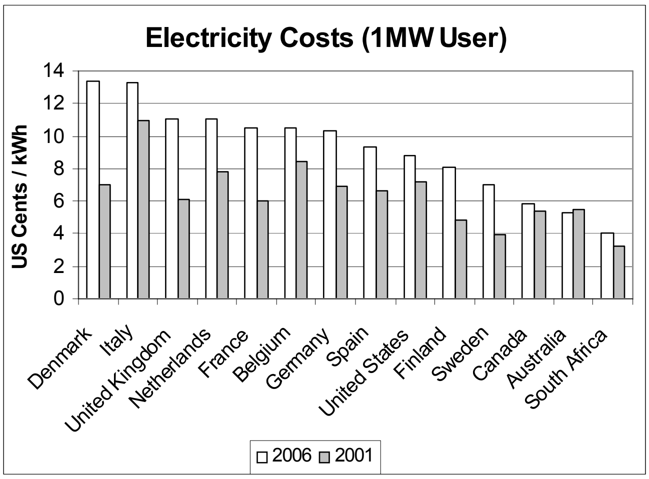


Figure 15: Indicative Electricity Prices

The chart shows electricity cost estimates for a 1MW user compiled by NUS [2]. Obviously this level of usage is considerably lower than that of the typical ferroalloys smelter. However the chart does demonstrate the increases in costs in most developed economies in 2006 over 2001.

High-carbon ferrochrome is mainly priced on a quarterly basis. Actual transaction prices have been at an ever widening discount to the nominal "headline" price posted by the producers each quarter. The volatile rand has become a major influence on the ferrochrome market due to the importance of South Africa as a producer. From 2002, China became a net importer for ferrochrome and looks set to grow as a market in the future.

Costs for ferroalloy smelters have generally been rising over the past five years or so. Open-cast reserves for chrome ore have mostly been mined out in countries such as South Africa, requiring investment in underground mining. In 2005 chrome and manganese ore prices were at levels historically high compared to alloy prices. Pre-smelting agglomeration (pelletizing, briquetting) has become the norm to utilize metallic and ore fines, which would otherwise be sold off at a discount.

Coke shortages led to prices peaking at more than $400/tonne fob in 2004, and they have continued at levels some way over the historical average. In coal-producing countries, such as South Africa, low-cost "coke substitutes" exist that are able to reduce the reductant cost to some extent. There remains ongoing interest in low-coke or even coke-free metallurgical processes.

Whereas in the past, electricity was often supplied to large-scale users, such as ferroalloys smelters, at preferential rates by state-owned utilities, there has been a move to market-based pricing in Europe and North America since the start of the decade. In the developed regions, smelters require captive capacity or long-term contracts at low prices to remain competitive in the long term. In less developed countries, spare power availability has been shrinking due to rising demands of the populations, and electricity prices also appear to be rising.

REFERENCES

[1] Banerjee, S., "The World of Chromite Ore", ICDA Conference, 2006.
[2] National Utility Services, "Electricity Report & Cost Survey", 2006.