INFACON 7, Trondheim, Norway, June 1995
Eds.: Tuset, Tveit and Page
Publishers: FFF, Trondheim, Norway

FERROALLOY MARKETS

Jorn P. de Linde
Resource Strategies Inc., Exton, Pennsylvania, U.S.A.

ABSTRACT

The last decade brought major changes to the ferroalloy markets. Against this backdrop, the outlook for the main ferroalloys is discussed. The major factors that will determine the future demand and supply of ferroalloys are examined. Following the assessment of market fundamentals and prices, possible changes in the competitive environment are outlined.

INTRODUCTION

A market can be defined as "the area of economic activity in which buyers and sellers come together and the forces of supply and demand affect prices" [1]. The following graph (Figure 1) compares price trends for the main ferroalloys, i.e., high-carbon ferromanganese, ferrosilicon, silicomanganese, high-carbon ferrochrome/charge chrome and silicon metal.

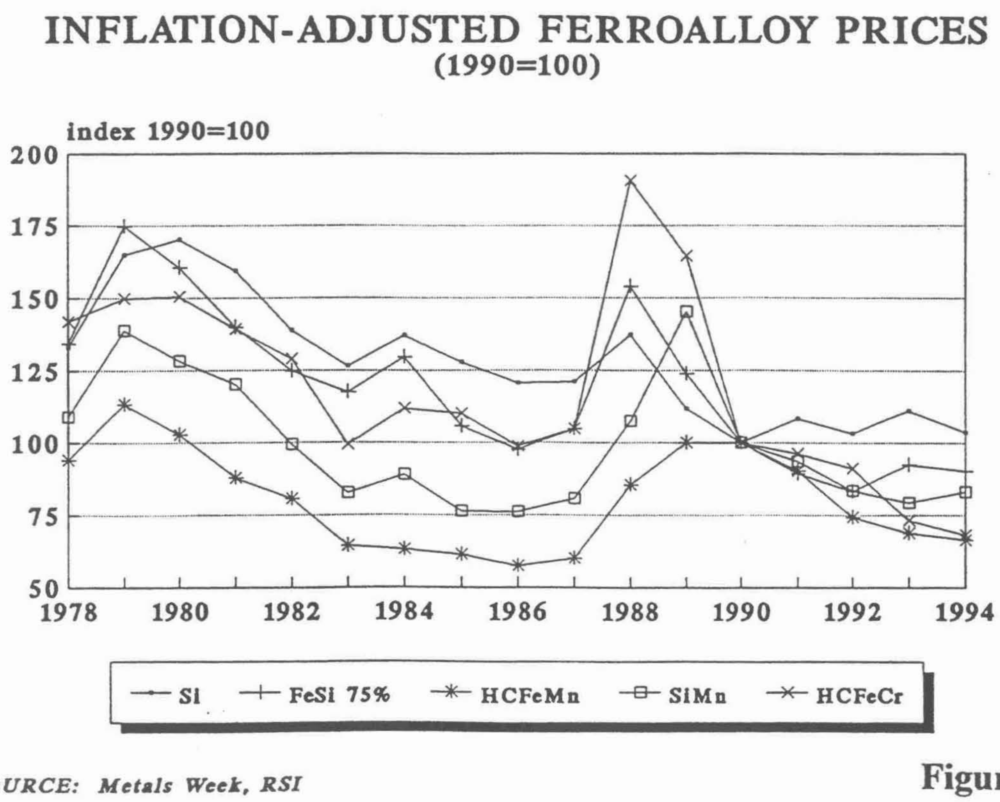


Figure 1

The picture that emerges is one of gradually declining prices. This price erosion can be attributed to frequent oversupply combined with falling industry supply costs, reflecting both shifts in production from higher-cost to lower-cost locations and improved operating efficiencies.

Although the pattern is broadly similar, significant disparities exist in the price history of individual ferroalloys. These discrepancies stem from variations in the underlying rate of demand growth; specific supply side developments, including the uneven impact of changes in East/West trade; and considerable differences in the underlying production cost structure.

Each of these factors will be examined in turn, focusing on the future market conditions for the main ferroalloys.

DEMAND

The demand for ferroalloys is primarily determined by developments within the iron and steel industry. Ferroalloys impart distinctive qualities to steel and cast iron and also serve important functions during the production process. Except for silicon metal, the major determinants of demand are:

* The levels of steel and cast iron production.
* The types of steel and cast iron produced.
* Steelmaking and iron casting processes and technology.

After reaching a peak of almost 786 mn tonnes in 1989, world crude steel production has fallen by about 63 mn tonnes, or more than 8% (Figure 2). The principal reason for the decline in total output has been the sharp contraction of production in the former Soviet Union, and to a lesser extent, Eastern Europe and Japan.

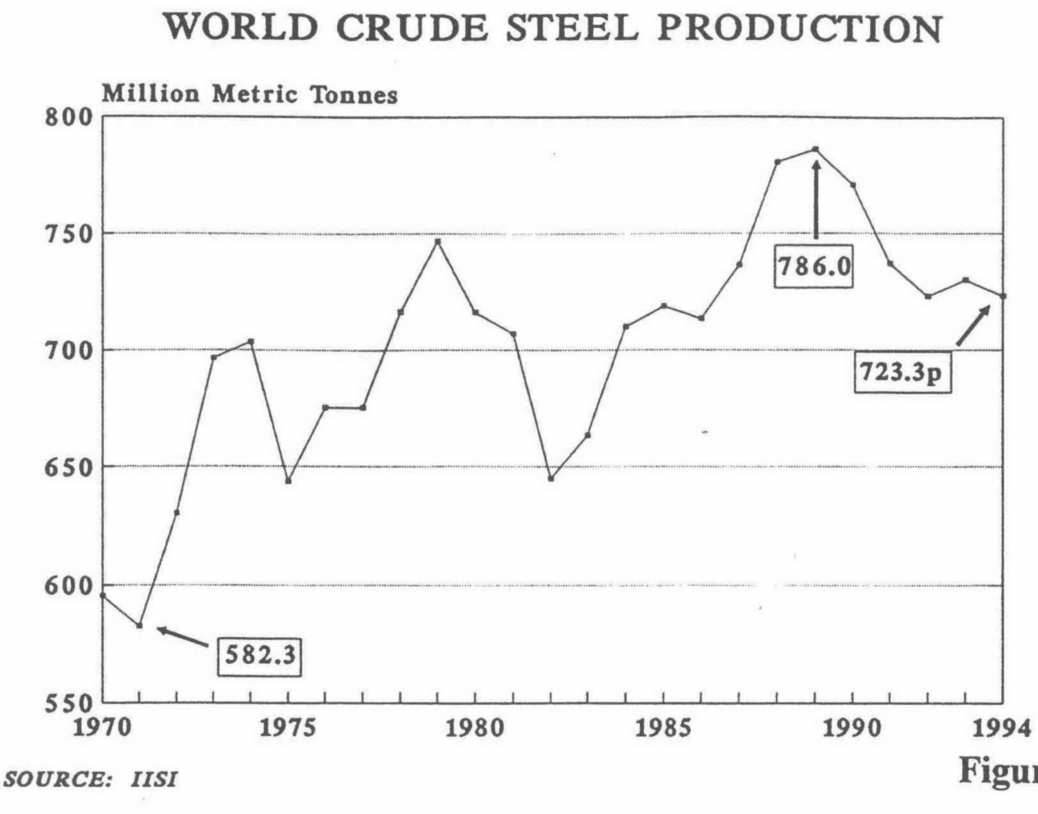
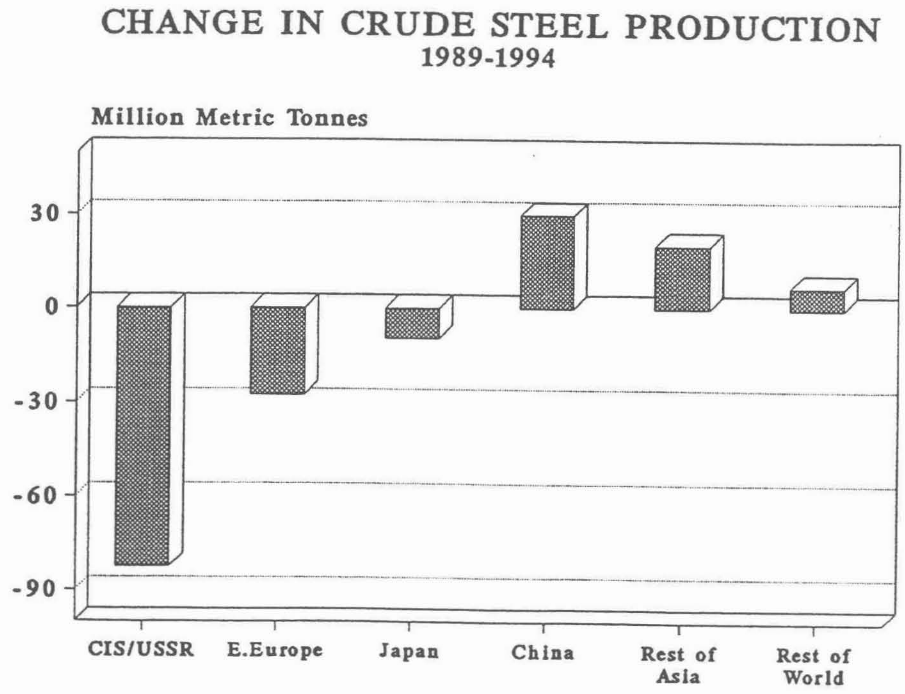


Figure 2

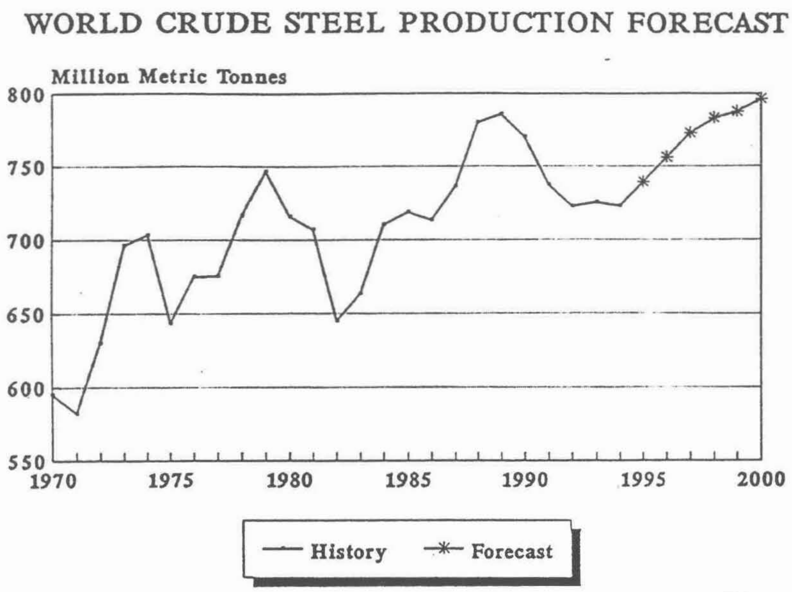
Partly offsetting this decline has been a 50 mn tonne increase in other Asian crude steel production, of which more than half is attributable to China (Figure 3). Mainly due to the rapid increase in Asian output, Western world crude steel production is now at an all-time high with back-to-back records posted in 1993 and 1994.



SOURCE: IISI

Figure 3

Based on an acceleration in economic growth throughout the Western world, combined with further strong gains in China, a turnaround in Eastern Europe and an eventual recovery in the former Soviet Union, world crude steel production is projected to approach 800 mn tonnes by the turn of the century (Figure 4).



SOURCE: IISI (History), RSI (Forecast)

Figure 4

Over the period 1994-2000 as a whole, this growth will be split relatively evenly between Western countries, China and the CIS/Eastern Europe (Figure 5).

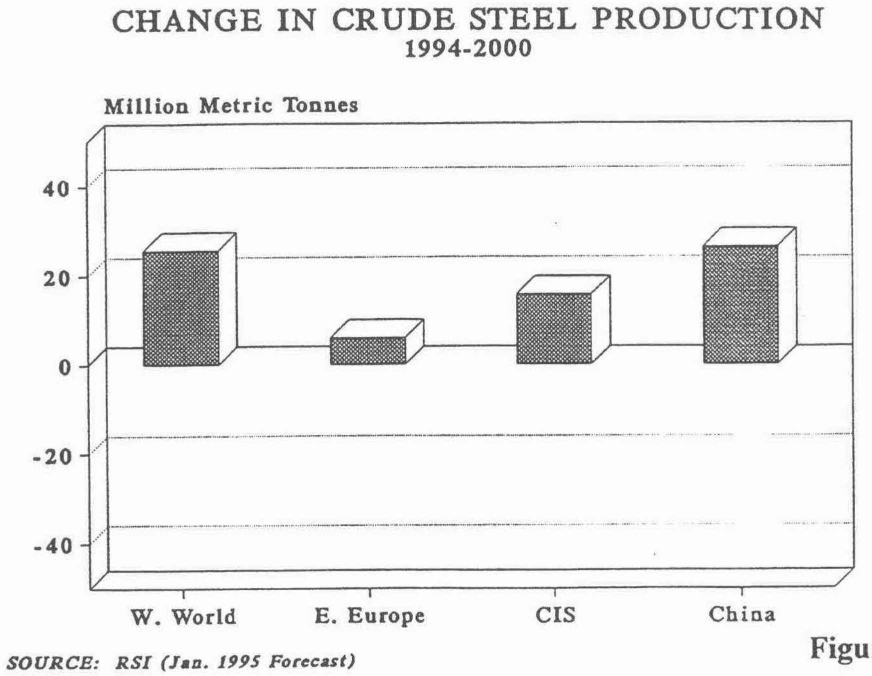


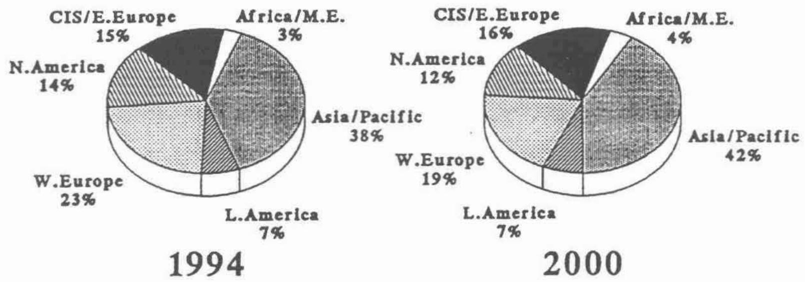
Figure 5

Due to a combination of structural changes, the underlying growth in crude steel production will remain substantially below the rate of world economic expansion. The falling intensity of steel use is related to the increasing importance of service industries relative to manufacturing. It also reflect material substitution and the move towards thinner, lighter-weight steels. Finally, crude steel production will continue to be adversely affected by improvements in steelmaking efficiencies.

Nevertheless, the impact of some of these developments may be considerably smaller than was the case over the past two decades. Not only is there a moderating trend in material substitution, but yield improvements are likely to occur at a diminishing rate. The ratio of finished steel consumption to crude steel production already exceeds 80% for the Western world, having risen by more than 10 percentage points since 1975. Given that most yield enhancements already have been accomplished, at least in the industrialized countries, future crude steel production growth rates should more closely match the growth in finished steel consumption. In fact, Resource Strategies expects world crude steel production to advance at an underlying rate of close to 1.5% per annum over the next 10 to 15 years, double the 0.7% per annum rate posted since 1975.

Future growth in steel production mainly will occur in the developing and newly industrialized countries (Figure 6.). The market with the greatest potential is clearly the Asia/Pacific region, including India, South Korea, Taiwan, Malaysia, Thailand and China. Part of the expected growth in these countries will come at the expense of the main industrialized countries where further rationalization of steel capacity is expected, but production mainly will expand in response to higher global steel requirements.

DISTRIBUTION OF CRUDE STEEL PRODUCTION
(Percent Share)



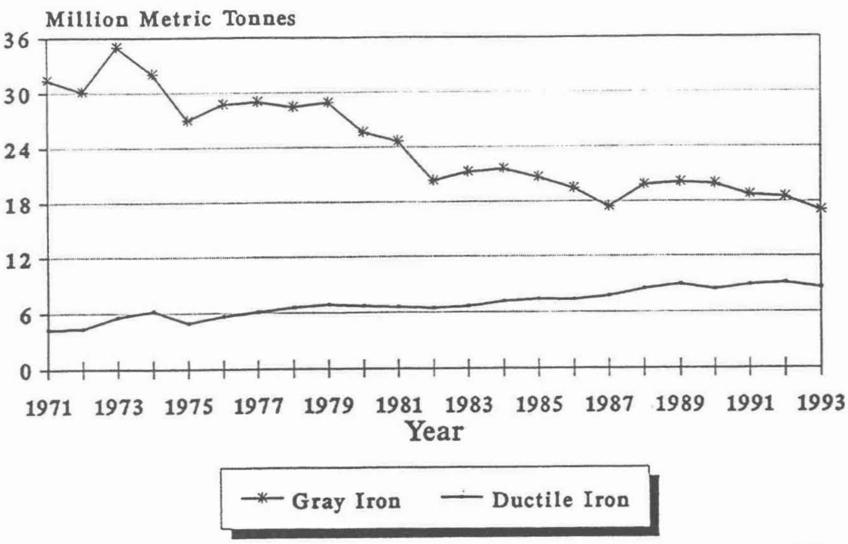
SOURCE: IISI, RSI (Forecast)

Figure 6

A substantial amount of ferrosilicon is consumed in the production of cast iron. The iron foundry industry has suffered from a number of structural problems. In certain segments of the casting market there has been strong competition from other materials. For example, aluminum and plastics have displaced cast iron in a variety of automotive and construction applications. Production volumes have been reduced further as a result of improvements in design and in casting technology which have permitted the development of thinner and lighter castings. As a result, there has been a downward trend in total foundry production.

Available statistics show that falling gray iron production has been offset partially by increased output of ductile iron (Figure 7). Ductile iron on average has a higher silicon content than gray iron, thereby limiting the overall decline in foundry-related ferrosilicon demand. Looking ahead, at best modest growth is likely in total cast iron production, although individual markets could show considerable gains.

W. WORLD CAST IRON PRODUCTION
Selected Countries



SOURCE: Modern Castings, RSI Estimates

Figure 7

Unit ferroalloy consumption is a function of both the type of steel produced and the steelmaking technology employed. The relative importance of these factors varies from alloy to alloy. Unit consumption of individual ferroalloys is influenced to some extent by the use of other alloying elements and interalloy substitution. For example, silicomanganese can frequently replace additions of ferrosilicon and vice versa. Apart from cost considerations, alloy selection is subject to various metallurgical and technical constraints. Similarly, the choice of specific ferroalloy grades to be used depends on the amount of alloying material to be added, various process factors, as well as a certain element of tradition. In the case of ferrochrome, unit consumption also is affected by variations in the use of scrap in stainless steel production.

The adoption of new steelmaking processes and practices generally has reduced specific ferroalloys consumption. The effect has been especially pronounced in the case of manganese. The following graph (Figure 8) shows the drop in the average Western world consumption of manganese in ferroalloys per tonne of steel produced.

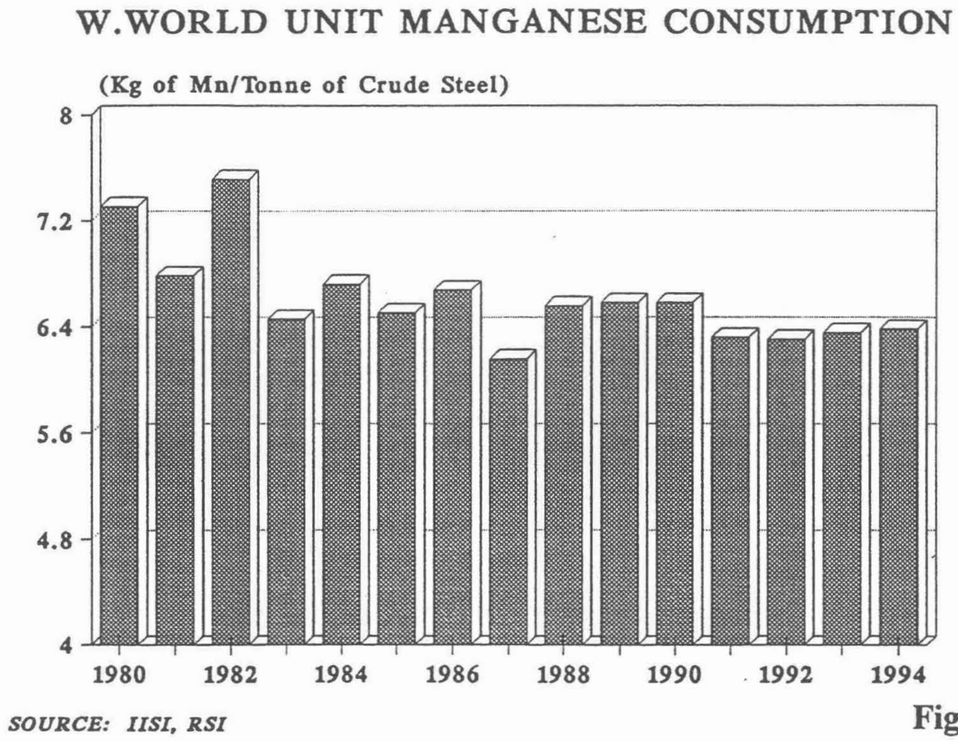
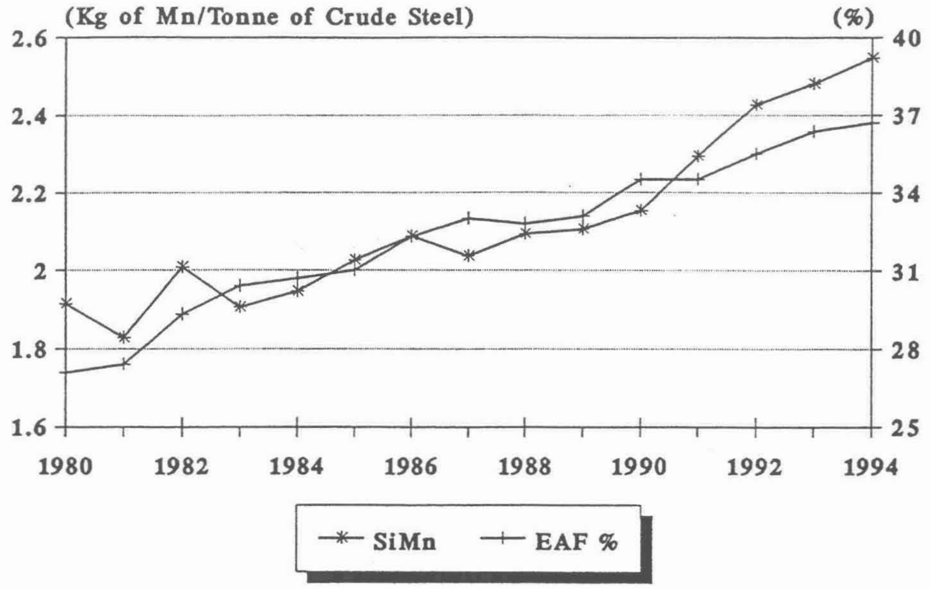


Figure 8

Dating back to the 1970s, this erosion was attributable mostly to the phasing out of open hearth steelmaking and the associated increase in basic oxygen and electric arc furnace steelmaking. Over time, there also have been improvements in oxygen steelmaking, specifically in the use of "combined blowing" processes. The increased use of secondary steelmaking and ladle metallurgy also has resulted in higher ferroalloy recoveries.

The decline in unit manganese consumption primarily has affected high-carbon ferromanganese. In fact, specific silicomanganese consumption has risen appreciably, concurrent with the gains of "mini-mills" and EAF-based steel production (Figure 9). Driven by a combination of technical and economic factors, Resource Strategies projects that the share of EAF-based steel production in the Western world will approach 45% by the year 2000.

W. WORLD SIMN UNIT CONSUMPTION VS. EAF-BASED STEEL PRODUCTION



SOURCE: IISI, RSI

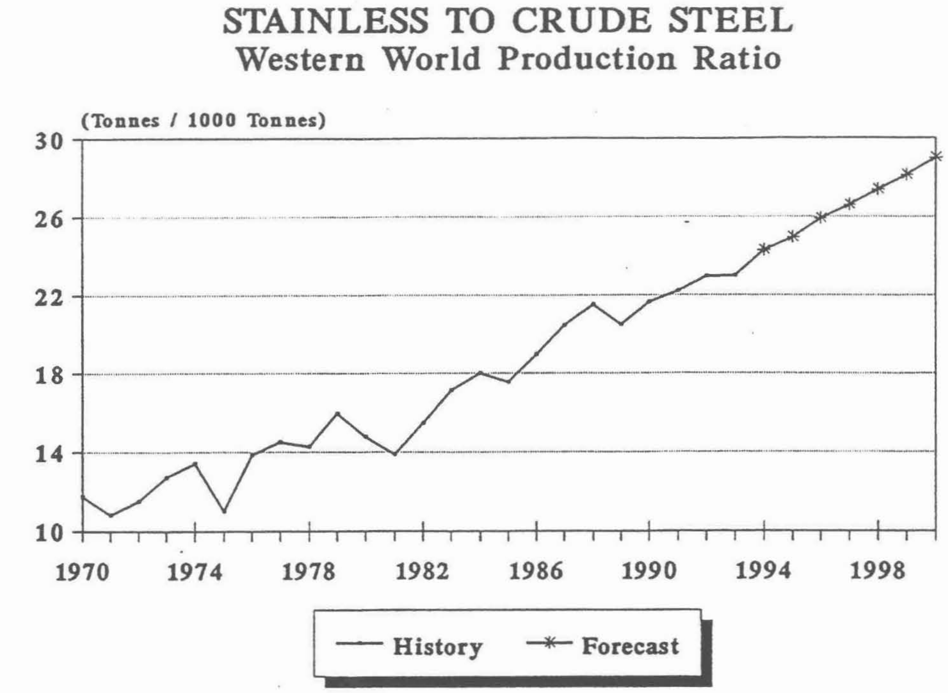
Figure 9

In the case of ferrosilicon, the relative gain in specialty steel production largely has offset technologically-induced consumption losses. Stainless steel production has increased at a substantially faster rate than crude steel production (Figure 10). This differential is likely to be maintained. In fact, Resource Strategies expect Western world stainless steel production to rise at a long-term rate of almost 4% per annum, which is close to the average rate posted over the last 15 years. This relatively strong growth reflects the special performance characteristics offered by stainless steel combined with a favorable trend in manufacturing costs vis-a-vis competing materials.

In the judgment of Resource Strategies, unit silicon and manganese ferroalloy consumption will be relatively stable in the industrialized nations. There remains, however, the potential for significant declines in unit consumption in many developing countries, linked most importantly to the phasing out of older steelmaking processes, generally improved process controls and better efficiencies of use.

Given this assessment of the key economic and technological variables affecting ferroalloys consumption, what is the long-term-outlook for demand?

Future consumption of ferrosilicon and manganese ferroalloys will be constrained by the relatively slow growth in total crude steel production. In contrast, the prospects for high-carbon ferrochrome/charge chrome are considerably brighter because of the close link to stainless steel production (Table 1).



SOURCE: IISI, WBMS, RSI (Forecast)

Figure 10

Table 1. Western world ferroalloy demand.

FERROALLOY	UNDERLYING GROWTH RATE	UNIT CONSUMPTION TREND
Ferosilicon	0.9 - 1.1% p.a.	Relatively Stable
High-Carbon Ferromanganese	0.0 - 0.2% p.a.	Falling
Silicomanganese	1.8 - 2.1% p.a.	Rising
High-Carbon Ferrochrome/ Charge Chrome	3.8 - 4.0% p.a.	Relatively Stable

SOURCE: Resource Strategies, Inc.

Compared to the manufacture of carbon steels, stainless steel production will remain relatively concentrated (Figure 11). Consequently, the geographical shifts in high-carbon ferrochrome/ charge chrome consumption will be much less pronounced than for the other bulk ferroalloys.

It should also be noted that the relative importance of the former Soviet Union, China and Eastern Europe is much smaller in the manufacture of stainless steel than in total steel production (Figure 12).

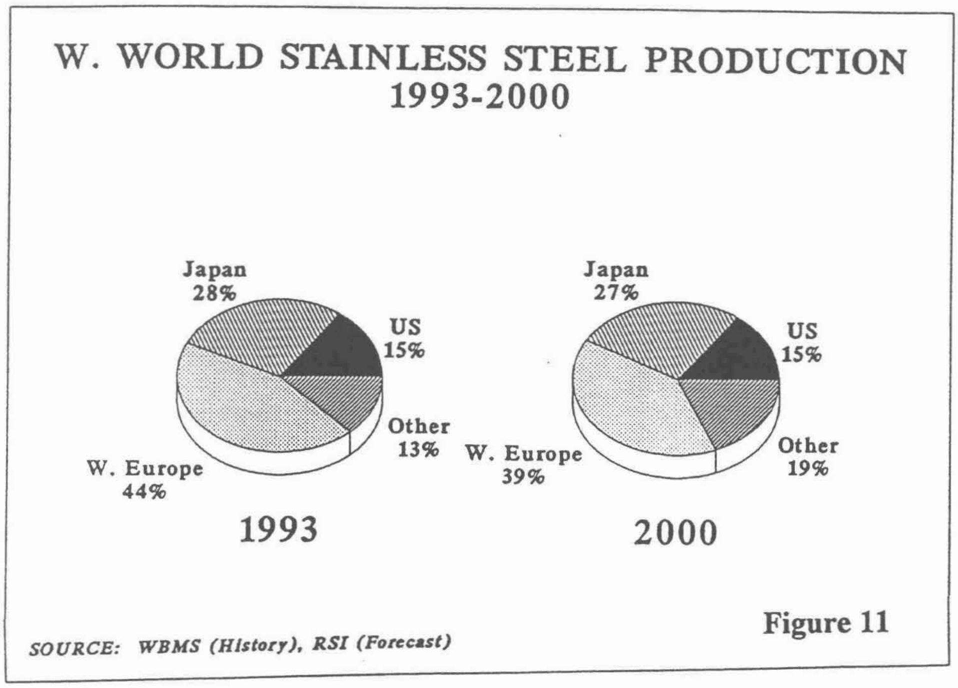


Figure 11

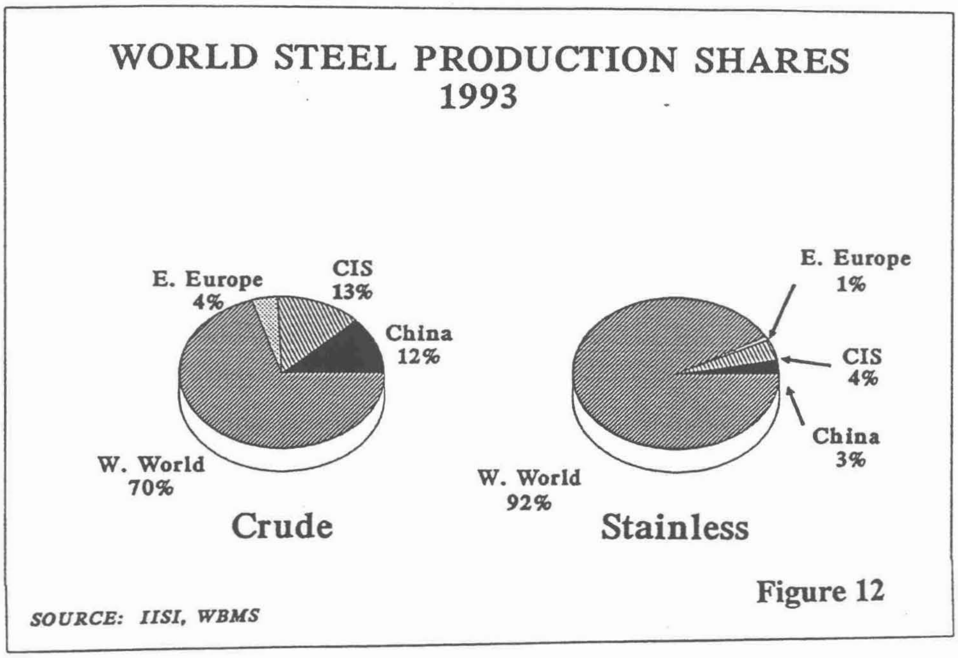
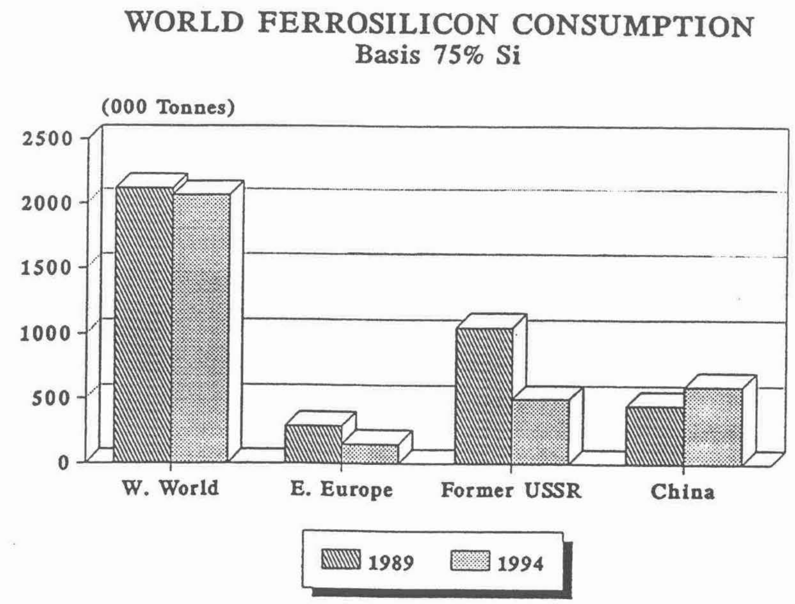


Figure 12

Unfortunately, comprehensive and up-to-date information is not available on the consumption of ferroalloys in China, Eastern Europe, and the former Soviet Union. However, by all indications unit consumption is considerably higher than in the West, reflecting a combination of technical and product mix factors, combined with generally lower efficiencies of use. The following graph (Figure 13) compares ferrosilicon demand in the former East Bloc countries to Western demand.

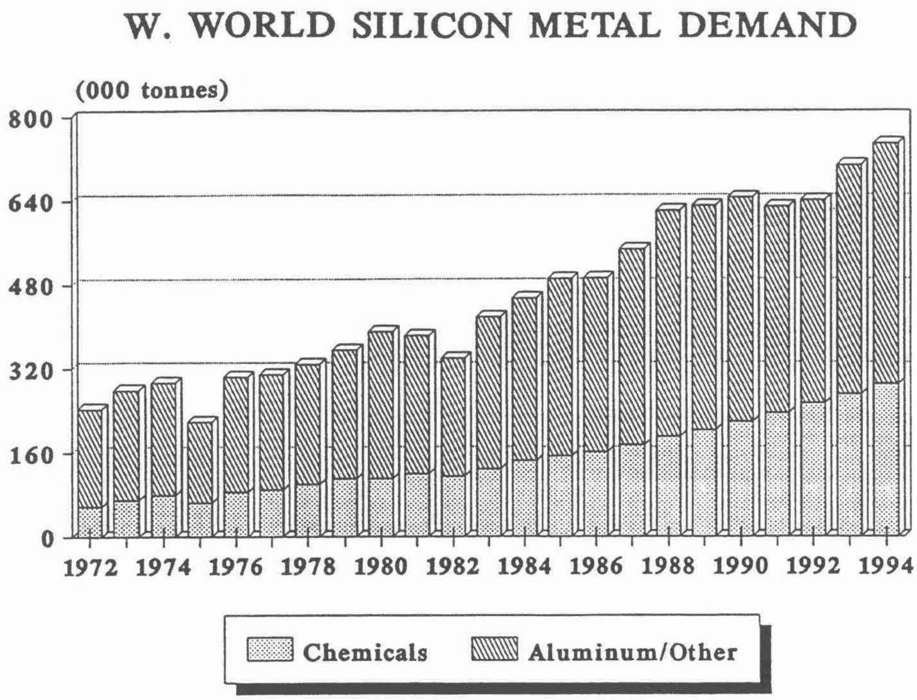
Because of the potential for substantial savings in unit consumption, ferroalloys demand in the non-Western countries will advance much more slowly than crude steel production. However, the consumption of high-carbon ferrochrome probably will increase rapidly (offset by falling low-carbon ferrochrome consumption) as the use of AOD and related processes are more widely adopted in the manufacture of stainless steel.



SOURCE: RSI

Figure 13

So far the discussion has focused largely on the relationship between iron and steel production and ferroalloys demand. In fact, by far the fastest consumption growth has occurred in silicon metal. Over the past two decades, Western world silicon demand, which is not related to iron and steel production in any significant way, has more than doubled (Figure 14).



SOURCE: RSI Estimates

Figure 14

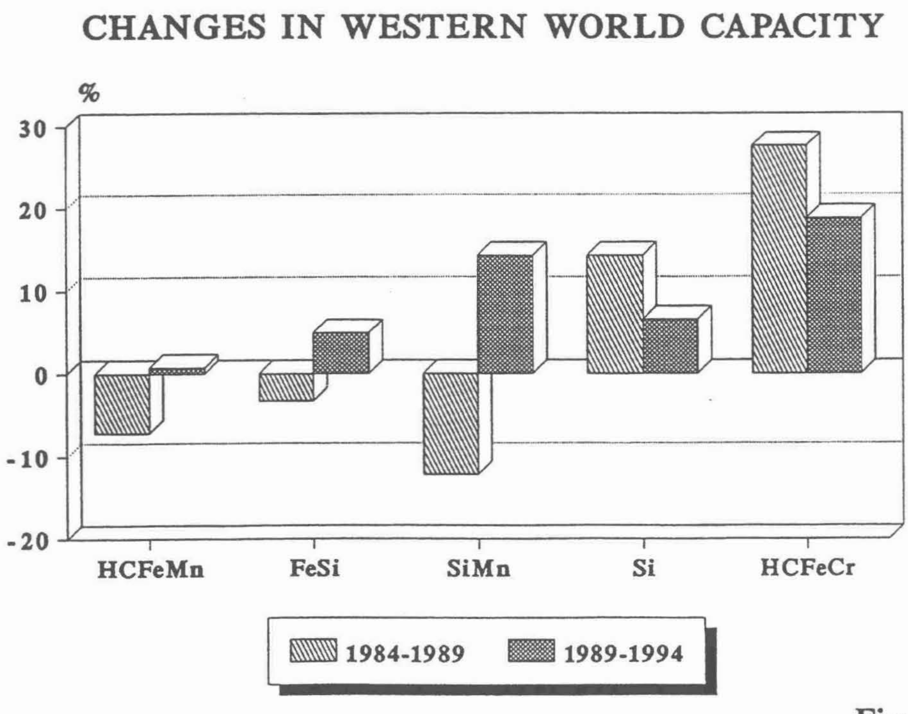
Although new applications such as ceramics or solar cells eventually could contribute substantially to demand, silicon metal consumption largely will be determined by developments in the major existing end-use markets (i.e., aluminum alloys and silicones) over at least the next 5-10 years. Supported by continued strong growth in chemicals-related consumption, as well as further substantial expansion in the manufacture of aluminum foundry alloys (principally for automotive applications), Western world silicon demand is projected to increase at a long-term rate of about 5% per annum.

Again, limited information is available on demand in the former East Bloc, but it is evident that silicon metal consumption in these countries is relatively small, both in absolute terms and in relation to Western consumption. Current silicon demand in China, Eastern Europe and the CIS probably total less than 100,000 tonnes per annum.

SUPPLY

While essentially demand-driven, ferroalloys production depends on available capacity, cost competitiveness and various institutional factors. Since a separate paper is devoted to the "Future Localization and Structure of the Ferroalloys Industry", the following discussion will touch only briefly on many supply-related issues.

The following graph (Figure 15) compares the relative changes in Western world ferroalloy capacity that have occurred since 1994.



SOURCE: RSI

Figure 15

Not surprisingly, the changes in aggregate capacity generally reflect the underlying growth in consumption for each alloy. It also is evident that for all the ferroalloys considered, except high-carbon ferromanganese, Western capacity increased by varying degrees between 1989 and 1994 (i.e., at the same time as there was a rapid escalation of ferroalloy exports from China, Eastern Europe and the former Soviet Union).

The nameplate capacity estimates presented include certain furnaces that have been idle for extended periods of time due to a lack of cost competitiveness and various special circumstances. It should also be noted that effective capacity in some instances is reduced appreciably as a result of power availability or cost considerations. For example, Resource Strategies estimates that the gap between effective and nominal ferrosilicon capacity ranged from 15% to 20% during the early 1990s.

The changes in total capacity mask substantial regional differences. Cutbacks in the major industrialized countries have been offset by considerable growth elsewhere. Even in the case of high-carbon ferromanganese, significant new capacity has been added in some locations. Most of the expansion of manganese and chromium ferroalloys capacity has occurred in ore producing nations, with the objective of adding value to their mineral exports. Meanwhile, Latin America has accounted for most of the new capacity in silicon-based ferroalloys.

A number of developments have contributed to the gradual relocation of Western world ferroalloy capacity and production; including shifts in demand, changes in the availability and cost of electric power, and stricter environmental regulations. Another important factor has been access to competitively priced raw materials. The principal raw materials required for the manufacture of ferroalloys are ore and reductants.

In order to assess the impact on cost competitiveness, it may be useful to compare and contrast the cost structure of each ferroalloy. Obviously, the relative importance of each cost component is a function of specific consumption (i.e., the amount of inputs required per tonne of output), as well as respective unit prices.

The following table (Table 2) shows the production-weighted distribution of operating costs by major cost category for each ferroalloy. It is evident that ore is the principal cost factor in the production of high-carbon ferromanganese, while electricity constitutes the largest individual cost element in the manufacture of silicon-based ferroalloys. In the case of silicomanganese and high-carbon ferrochrome, ore and electricity are about equally important. Both ore and electricity costs, in turn, are closely linked to local resource endowments. Transportation costs are included in this comparison because ferroalloys typically are sold on a delivered basis. The "Other" cost category included certain raw materials such as fluxes, iron ore/scrap for ferrosilicon, miscellaneous consumables, sales and administrative expenses, and maintenance.

Table 2. Distribution of Operating Costs - 1994 (percent)

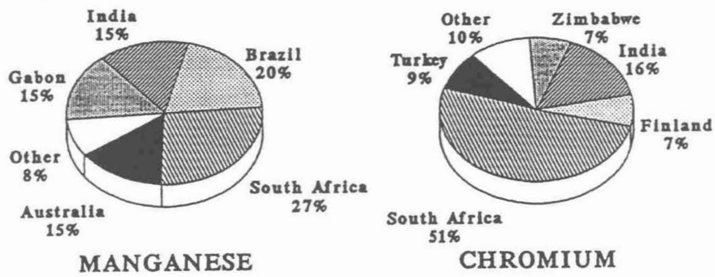
	Si	FeSi	SiMn	HCFeMn	HCFeCr
Ore	7.1	7.3	24.1	34.6	21.7
Reductants	16.6	17.6	8.8	9.0	12.5
Electrodes	14.9	3.7	2.5	1.5	1.7
Electricity	22.4	25.3	21.2	16.5	24.7
Labor	14.8	14.5	12.1	9.8	9.3
Other	19.0	22.2	19.4	14.8	16.0
Transportation	5.2	9.4	11.9	13.8	14.1

Source: Resource Strategies, Inc.

Ore, in the form of quartz, constitutes a relatively small fraction of total operating costs in the manufacture of silicon ferroalloys, although quartz quality is quite important, especially in the production of silicon metal. Silicon-bearing raw materials are found in a number of locations throughout the world, although deposits no not necessarily occur in areas where inexpensive energy is available.

Chromium and manganese also differ from silicon in that ore production and reserves are concentrated in relatively few countries (Figure 16). A total of only five countries -- South Africa, Brazil, Australia, Gabon and India -- account for more than 90% of the total Western world output of manganese ore. Similarly, South Africa, India, Turkey, Zimbabwe and Finland together provide almost 90% of Western chromite production.

WESTERN WORLD PRODUCTION DISTRIBUTION
AVERAGE 1991-1993 - GROSS WEIGHT BASIS



SOURCE: USBM, RSI

Figure 16

The distribution changes significantly when non-Western supply is taken into consideration (Figure 17). However, it should be pointed out that Ukrainian and Chinese manganese production mostly is in the form of lower-grade ore.

The underlying resource position in manganese and chromium ore is even more concentrated, with South Africa controlling a majority of reserves (Figure 18).

While silicomanganese production can be based on widely available, lower-cost siliceous ore, access to high-grade manganese ore is essential in the manufacture of ferromanganese. Not only is the mining of high-grade manganese ore geographically concentrated, but also it is controlled by a handful of suppliers.

Except for the mid-1980s, the price of high-grade manganese ore has exceeded the associated mining and transportation costs by a significant amount, reflecting the oligopolistic nature of this industry. Consequently, ferromanganese producers who have access to low-cost ore have enjoyed a significant raw materials cost advantage.

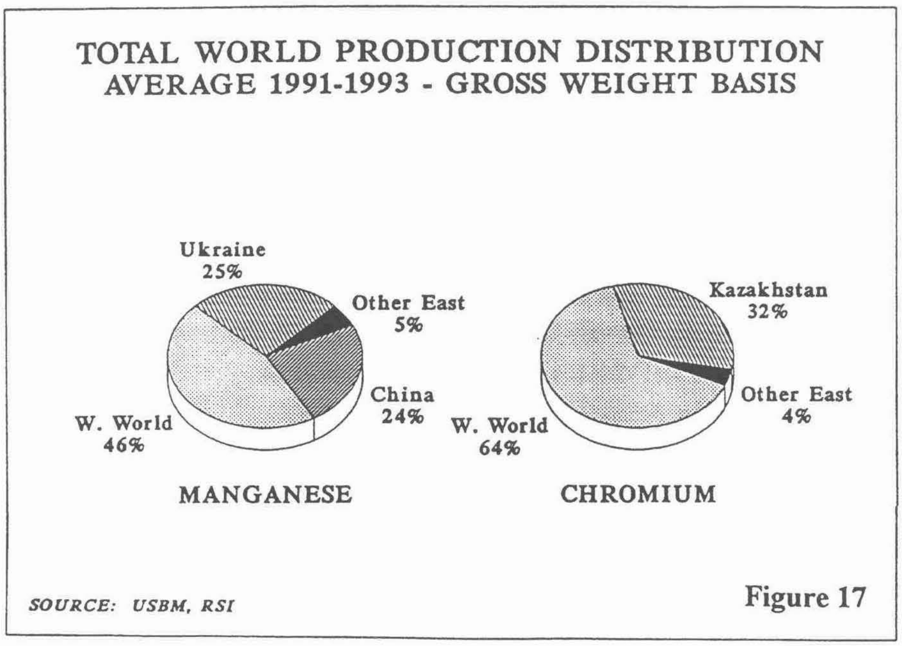


Figure 17

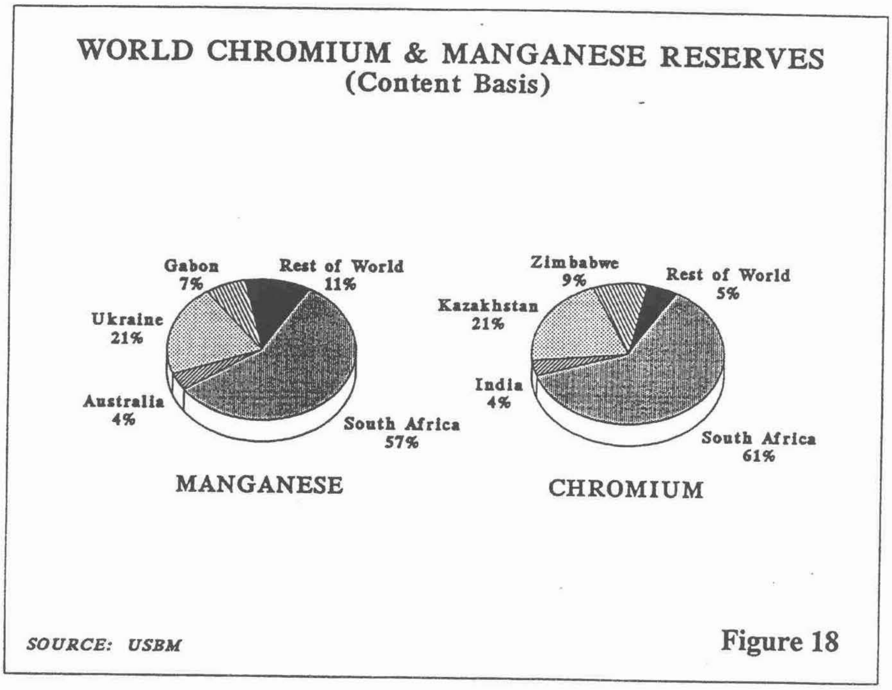


Figure 18

Compared to other ferroalloys, the ferromanganese industry has been characterized by a relatively high degree of vertical integration. Historically, steelmakers accounted for a significant share of ferromanganese capacity. More recently, there has been a trend towards closer links between the producers of manganese ore and the producers of ferroalloys. The following graph (Figure 19) shows the share of Western world manganese ore that is consumed by "captive" operations. This share likely will increase further over the next several years.

By gaining access to low-cost ore, ferroalloy manufacturers have enhanced their competitive position and have limited their exposure to ore market risk. Meanwhile, the ore producers have been able to secure additional outlets for their ore, compensating for the loss of sales to the former Soviet Union and several major Western consumers. Through higher and more stable capacity utilization, unit mining costs have been reduced. Furthermore, the major ore producers have obtained partial or full control of low-cost conversion capacity in closer proximity to the main markets.

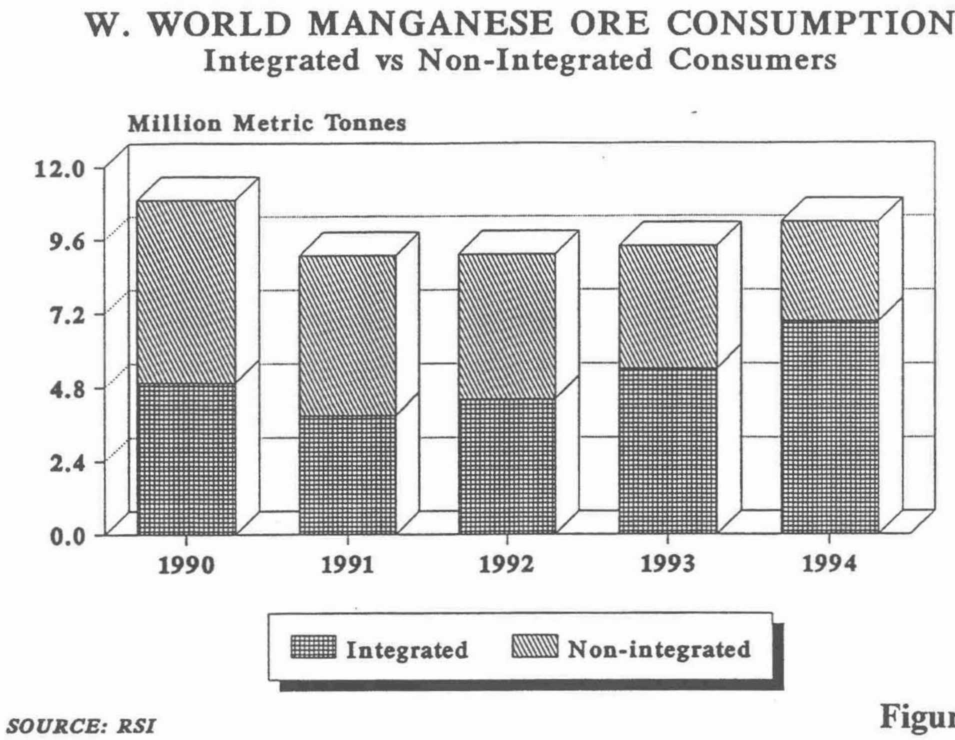


Figure 19

In the case of chromium, a large increase in chromite exports from the former Soviet Union (principally Kazakhstan) has provided non-integrated Western ferrochrome producers with competitively priced ore (Figure 20). During 1992 and 1993, Kazakhstan also was a leading exporter of chromium ore to China.

Indications are that production at Donskoy decreased significantly in 1994. Considerable uncertainties exist with respect to the future organization and commercial policies of the Donskoy mining complex and the Kazakh chromium industry. Developments in Kazakhstan will, in turn, have a major impact on the competitive position of non-integrated ferrochrome producers in the West, in Russia and, to some extent, in China.

In terms of reductant use there are considerable variations both by type of ferroalloy and by geographical location. Reductant choice is determined by local availability and cost, subject to constraints on quality and a variety of chemical and physical parameters for individual carbon materials and for the reductant mix. (In some instances, the furnace design and the off-gas system may limit or preclude the use of certain reductants.) Since most of the impurities contained in the reductants end up in the finished product, reductant quality and consistency are particularly important in the manufacture of high-purity silicon ferroalloys.

The cost of ores and reductants to non-integrated producers is generally subject to world market prices, and transportation is frequently a major source of cost differentials. In the case of ferrosilicon and, especially silicon metal, charcoal-based operations typically have a significant advantage in terms of reductant cost, especially when the effect on operating efficiencies is taken into consideration.

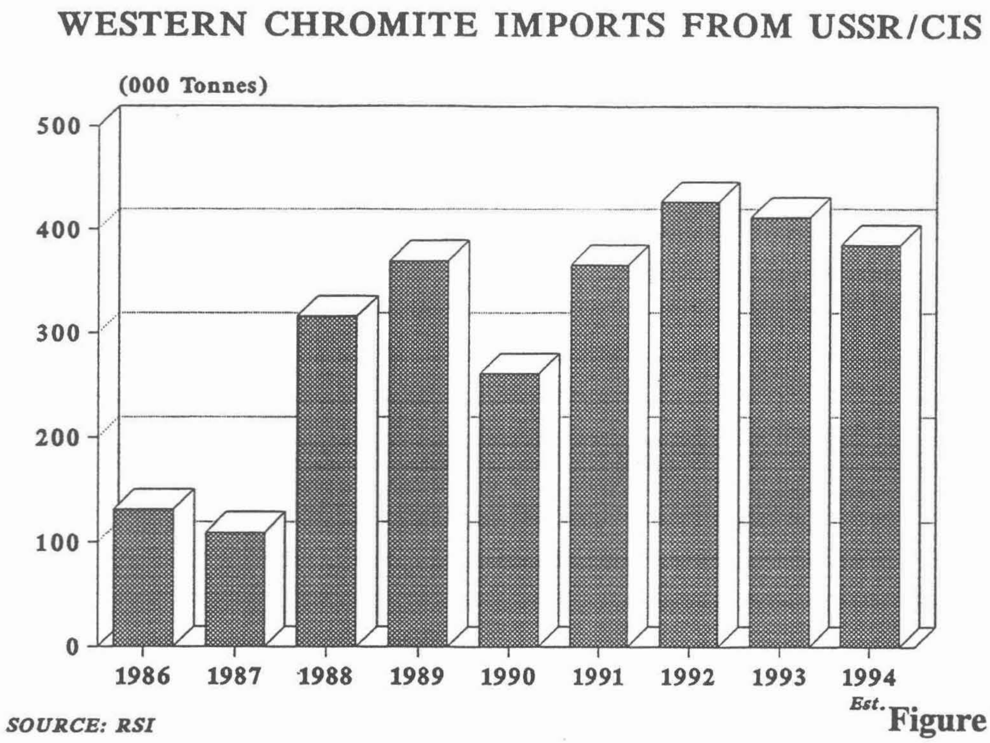


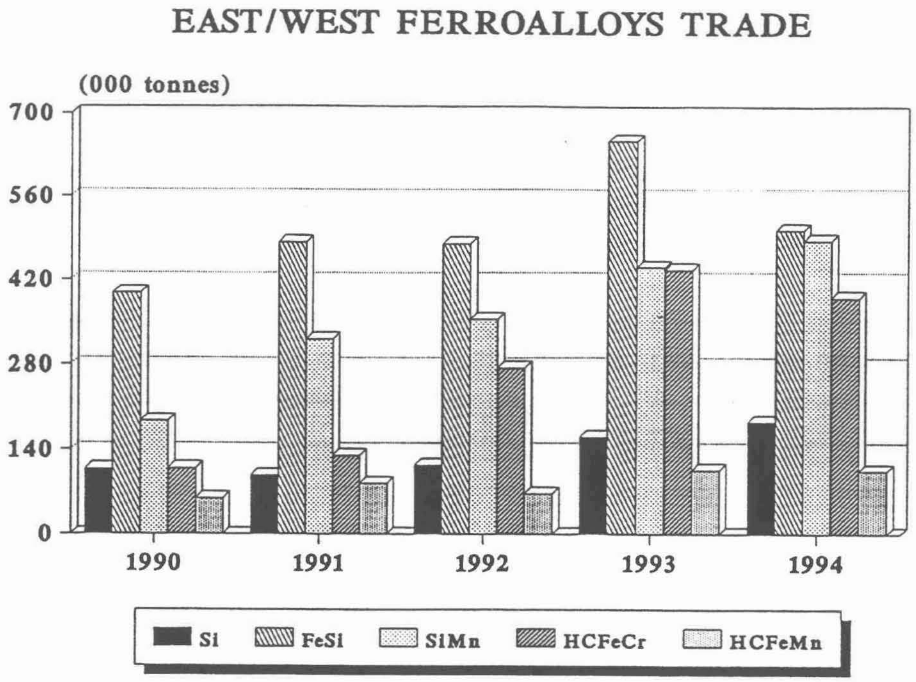
Figure 20

Smelting practices vary considerably more in the production of manganese and chromium ferroalloys than in the manufacture of silicon alloys. The differences are linked primarily to the preheating/prereduction of ore as well as the use of sinter. Moreover, a significant share of world high-carbon ferromanganese production is still derived from blast furnaces. These process variations, in turn, also affect reductant use and total carbon requirements. Proprietary smelting technology is especially prevalent in the ferrochrome industry.

A further dimension of cost competitiveness relates to the proportion of total operating costs that is incurred in local currency. This is linked closely to resource-based conditions which dictate the local availability and cost of raw materials and other inputs. With the exception of charcoal and woodchips, the pricing of reductants is influenced heavily by US dollar equivalent considerations, while electricity and labor costs generally are set in local currency. Of the different ferroalloys considered, ferrosilicon production costs are the most sensitive to exchange rate fluctuations.

In recent years, trade issues have had a significant impact on the markets for silicon metal, ferrosilicon and silicomanganese. Following anti-dumping proceedings in the United States and the European Community, substantial anti-dumping duties and other restrictions have been imposed on a wide range of overseas suppliers. Generally speaking, the penalty duties have created or amplified regional price differentials and have, to some extent, affected output levels of individual producers. These effects will diminish gradually as trade flows are redirected.

Required Western ferroalloy production partly is determined by the level of ferroalloy exports from China, Eastern Europe and the former Soviet Union. Ten years ago the Western world was a limited net importer of ferrosilicon, high-carbon ferrochrome and silicomanganese. a limited net exporter of silicon metal and a small net exporter of high-carbon ferromanganese. By 1990, the West had become a significant net importer of all these ferroalloys. Imports soared during the early 1990s, as illustrated by the following graph (Figure 21).



SOURCE: RSI

Figure 21

This surge was sparked by the dramatic political and economic changes that occurred in Eastern Europe and the former Soviet Union, triggering a collapse in local demand, while making hard currency-based ferroalloy exports extremely attractive. Concurrently, China became a substantial exporter of chromium and manganese ferroalloys, largely based on the conversion/tolling of imported ore, except in the case of silicomanganese. During the second-half of the 1980s, China already had emerged as a leading supplier of silicon-based ferroalloys.

In assessing the future level of East/West trade, it must be appreciated that there are fundamental institutional, economic and financial differences among the individual ferroalloy facilities in the former East Bloc countries. Furthermore, compared to Western operations, there are on balance considerably larger variations in plant size and in product range.

The rapid growth in Chinese steel production will be accompanied by a significant increase in domestic ferroalloy requirements, even when potential reductions in unit consumption are taken into consideration. Moreover, the production of silicon-based ferroalloys will be constrained by the cost and availability of electricity, except in the more remote provinces. Monetary and financial reforms likely will raise effective production costs over time, thereby gradually reducing the attractiveness of ferroalloy exports.

Unlike China, ferroalloys output in the former Soviet Union has declined sharply since the late 1980s. Indications are that total production is still falling, reflecting a combination of factors, including shortages of electricity and raw materials, a gradual rise in real production and transportation costs, logistical bottlenecks and, to a certain degree, the trade restrictions imposed by the European Community and the United States.

Although exports from the CIS to the West show signs of abating, a vast ferroalloy manufacturing base exists in Kazakhstan, Russia and the Ukraine. A large part of potential production will remain available for export, since it probably will be the late 1990s before a meaningful recovery in domestic ferroalloys consumption occurs.

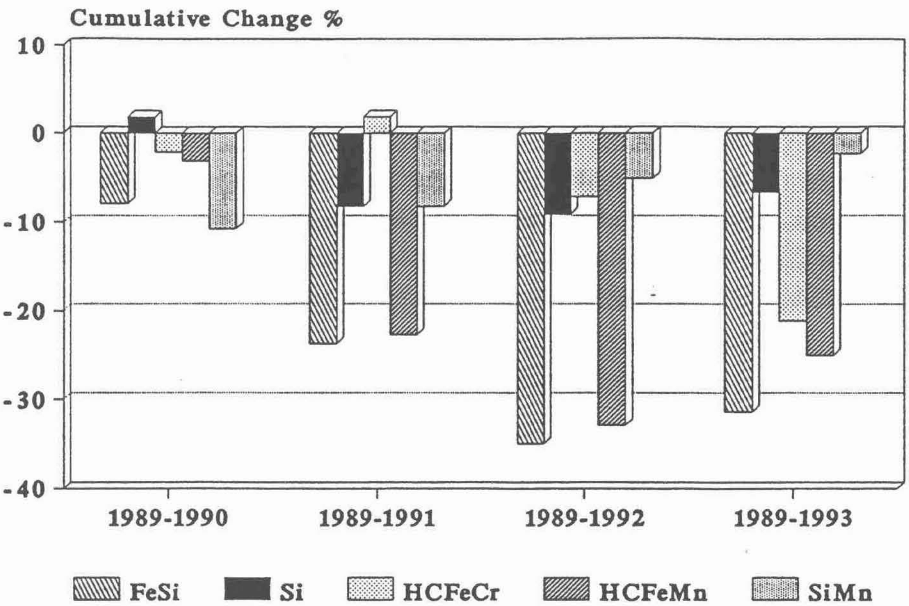
Eastern Europe as a whole is not expected to remain a significant net ferroalloys exporter due to the general lack of indigenous ore resources and low-cost electricity. Nevertheless, the region probably will remain a net exporter of some ferroalloys, notably ferrochrome, to the west through the late 1990s and beyond.

The non-Western plants that are fundamentally cost competitive are expected to survive and prosper on a long-term basis. As the transition to a market economy continues, producers in the former East Bloc countries are likely to focus increasingly on the manufacture of ferroalloys in which they hold a comparative advantage.

MARKET BALANCES AND PRICES

The escalation of ferroalloy exports from China, Eastern Europe and the former Soviet Union coincided with a worldwide economic slowdown and a downturn in Western crude steel production. The result was a sharp drop in Western ferroalloy output (Figure 22), compounded by previous inventory accumulation. Capacity utilization rates declined even more precipitously due to the significant Western capacity additions that occurred in the wake of the 1988/89 boom.

W. WORLD FERROALLOYS PRODUCTION

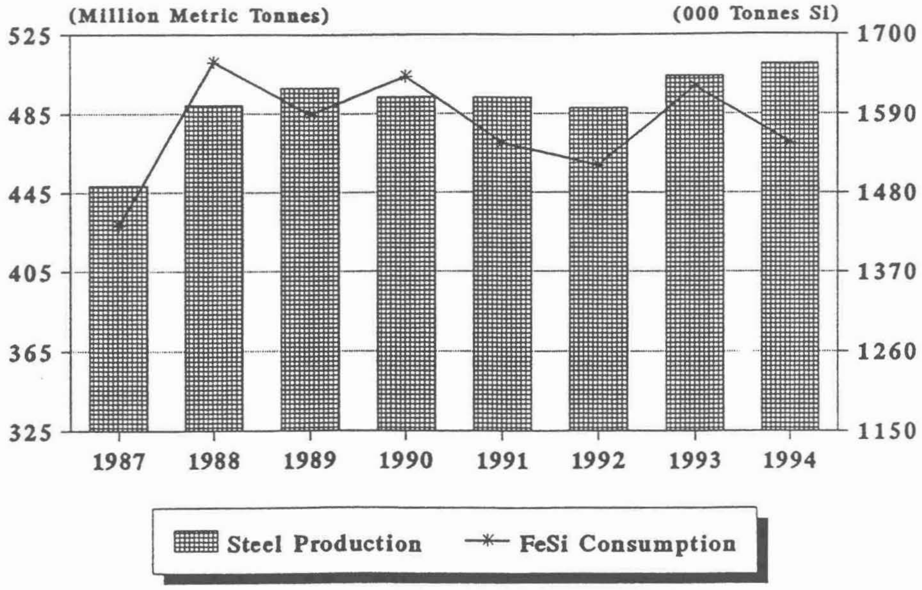


SOURCE: RSI

Figure 22

Inventory movements have to a considerable extent concealed the initial recovery in consumption (Figure 23), but Western ferroalloys demand is now increasing significantly in response to rising crude and stainless steel production. This cyclical recovery, while relatively moderate by historical standards, is expected to extend through 1997. Western silicon metal demand also is projected to increase at an above trend rate during this period.

STEEL PRODUCTION vs. FERROSILICON DEMAND
Western World



SOURCE: RSI

Figure 23

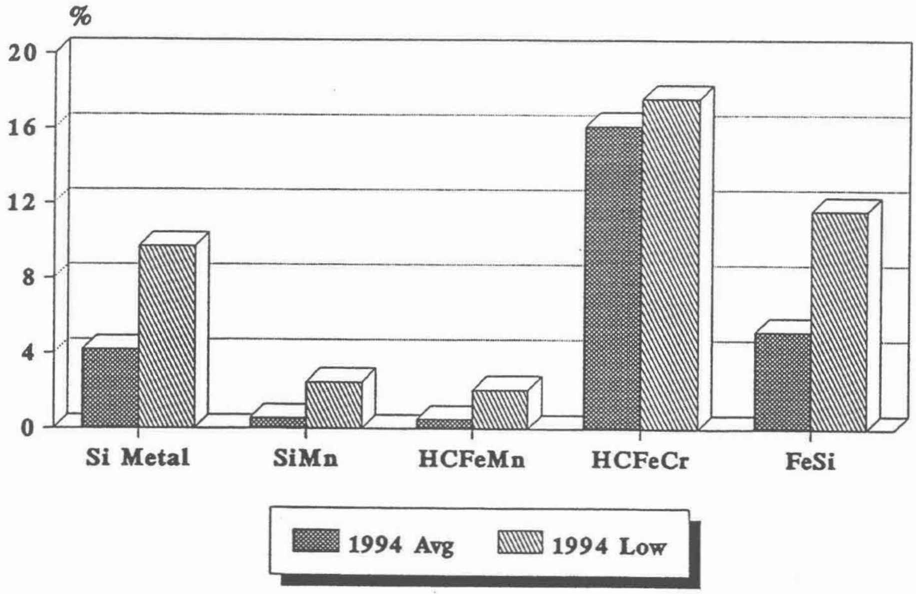
Net ferroalloy capacity additions are expected to be relatively modest during the next one to two years. Only a limited number of new plants and furnaces are under construction as of early 1995, while there is the potential for further rationalization of high-cost Western capacity. Finally, total ferroalloy exports from China, Eastern Europe and the former Soviet Union appear to be falling or at least stabilizing. Thus, the projected increase in Western demand largely will be met by Western ferroalloy producers, and industry operating rates are expected to rebound substantially, accompanied by higher prices.

This broad-based recovery should restore profitability to most sectors of the ferroalloys industry. As of late January 1995, prices for high-carbon ferrochrome/charge chrome, ferrosilicon, and silicon metal has already increased significantly compared to last year's levels (Figure 24). Manganese ferroalloy prices had been somewhat slower to improve due to a lingering stock surplus.

None of the ferroalloys considered are traded on terminal commodity markets, and there is no single definitive or dominant price. Significant geographical price variations currently exist, partly due to the impact of anti-dumping duties. Consequently, the rate of price appreciation will differ considerably between different regions.

On a longer-term basis, the rate of demand growth and the underlying production cost structure are likely to be the principal determinants of ferroalloy prices. Shifts in East/West trade and other developments can have a sudden, major impact on the markets, but the effect will diminish over time as producers and consumers adjust to changes in the competitive environment.

FERROALLOY PRICE MOVEMENTS
End-January 1995 vs. 1994



SOURCE: METALS WEEK, RSI

Figure 24

The rapid growth projected in silicon metal and high-carbon ferrochrome/charge chrome consumption means that substantial new capacity will be required to meet future demand. The need for additional capacity will exert upward pressure on prices, although it is likely that a large part of the necessary capacity can, at least initially, be met through reactivations, furnace conversions, and relatively low-cost expansions at existing plants. In the case of ferrochrome (as well as ferromanganese), slag recycling could be a significant source of future supply.

Future conversions primarily will reflect (perceived) long-term differences in the market outlook for individual ferroalloys, tempered by cost competitiveness considerations. Among Western plants, the largest ensuing capacity shift is expected to be from ferrosilicon to silicon metal, facilitated in part by the adoption of new electrode systems. Where furnace design, size and other technical parameters permit, production in some instances may be shifted between different ferroalloys on a more "opportunistic" basis to take advantage of shorter-term market fluctuations. To some extent, conversions also can be a net source of ferroalloys capacity (Table 3).

Table 3. Net Conversion Capacity - Ferroalloys

PLANT	COUNTRY	PRESENT PRODUCT	PREVIOUS PRODUCT
Elkem Rana	Norway	Ferrochrome	Pig Iron
Rana Metall	Norway	Ferrosilicon	Pig Iron
Silicon Technology	South Africa	Ferrosilicon	Calcium Carbide
Azul (joint venture)	Venezuela	Ferromanganese*	Pig Iron
* Project (pending)			
SOURCE: Resource Strategies; Press Reports			

Compared to the West, plants in the former East Bloc countries, especially China, tend to manufacture a much broader range of ferroalloys, and significant shifts in product mix can occur. Meanwhile, furnace upgrading and modernization programs at ferroalloy plants in the former Soviet Union may entail relatively large-scale capacity conversions. Widespread redeployment of furnaces over time may in turn limit differences in industry operating rates and thus in the price performance of individual ferroalloys.

The long-term rise in ferroalloy prices will be moderated by continued cost reductions achieved through efficiency gains. Process improvements resulting in higher yields, both inside the furnace and in terms of finished production, will be accompanied by increased labor productivity and lower specific electricity consumption. In the case of silicon metal, pre-baked electrode consumption is falling sharply, and there is the potential for further savings through new electrode technology.

Offsetting these technical advances, reductant and electricity costs could be subject to significant escalation following several years of predominantly stable or falling prices. In order to contain power costs, supply arrangements based on non-firm electricity could become more widespread. In fact, an increasing share of Western ferrosilicon capacity probably will be operated on a "swing" basis, with operating decisions dependent on the relationship between ferrosilicon prices and electricity rates.

The economics of manganese and chromium ferroalloy production will remain highly sensitive to the cost of ore. Developments in the ore markets will, to a large extent, determine the underlying trend in ferroalloy prices. Although future changes in ore prices may not be reflected fully in the price of ferroalloys, the ability to raise ore prices is inherently constrained by the market value of manganese (Figure 25) and chromium ferroalloys. Eventually, large-scale disposals from the US government stockpile could have a significant transitional effect on the chrome and manganese markets.

In the near-term, high-grade manganese ore prices will be determined primarily by production and transportation costs at new mining operations, rather than at existing large-scale mines. The major producers of high-grade ore have substantial underutilized capacity and existing mines are capable of meeting projected demand well into the next century. In chromium, on the other hand, mining costs are likely to escalate significantly because an increasing share of future production will come from higher-cost underground mines.

Institutional changes, including future restructuring and consolidation, will have a substantial impact on longer-term chrome and manganese prices and on the ability of specific participants to influence ore or ferroalloy prices.

MARKET ENVIRONMENT

So far the discussion has focused principally on developments in the aggregate market, but how will these changes affect the buyers and sellers of ferroalloys?

In an environment largely characterized by oversupply and intense price competition, the early 1990s generally were a buyer's market. In fact, the main preoccupation of Western ferroalloy producers at that time was survival. This situation is gradually changing.

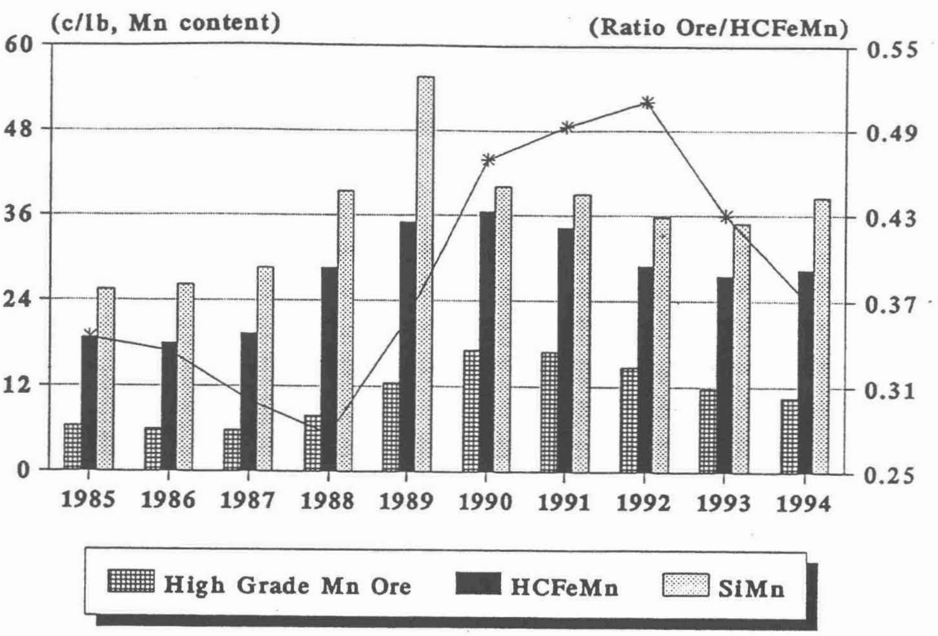
Looking back, the past decade clearly was a time of unprecedented change, brought about by several extraordinary events. The late 1980s and early 1990s saw a major expansion of Western ferroalloy capacity, partly in response to the surge in demand and prices that occurred in 1988/89. This coincided with a fundamental change in East/West ore and ferroalloy trade. Though it is often said that history repeats itself, it is difficult to envisage a set of developments over the next decade that could have an equally dramatic impact on the supply side of the ferroalloy markets.

Significant uncertainty still surrounds both the near and longer-term trade position of China and the Commonwealth of Independent States. By all indications, it will be a number of years before ferroalloy producers and consumers in these countries are fully assimilated into a truly global market. However, the distortions in exchange rates and input prices that have benefitted ferroalloy producers in the former East Bloc countries are disappearing. Thus, non-Western producers gradually are subject to more realistic production costs.

Historically, the ferroalloys industry has attracted new capacity even under relatively adverse market conditions. Economic and technological barriers to entry are relatively small. Investment in new facilities often has been encouraged as a part of broader industrial development schemes, aimed at adding value to local ore production or at utilizing local power resources. In many instances special incentives have been available, substantially reducing operating costs as well as capital servicing requirements. Moreover, as witnessed in the past, idle capacity can be reactivated not only as a result of improved market fundamentals, but also due to financial restructuring, ownership changes, and labor and electricity supply contract negotiations.

Nevertheless, there are indications that net Western capacity additions will slow considerably through the late 1990s and possibly beyond. Ferroalloy prices, in most instances, would have to increase substantially in order to justify new greenfield investment on a commercial/

UNIT VALUE OF MANGANESE



SOURCE: RSI

Figure 25

financial basis. Moreover, many of the potentially lower-cost, future projects are located in areas of considerable political and economic risk.

Although competition from new Western suppliers may become less intense, the potential for excess production remains. Because a substantial share of production costs is fixed, at least in the short-term, there is typically an incentive for producers to maximize output irrespective of market conditions. In the judgment of Resource Strategies, inventory management will continue to constitute a key challenge for the ferroalloys industry.

The instability in price and production volumes particularly has affected the markets for standard grades of ferroalloys. The manufacture of high-purity and special grades requires a higher degree of technical expertise and generally is undertaken in response to specific customer orders. Consequently, the markets for specialty products have been considerably less volatile.

While ferroalloy producers may be entering a period of less turmoil, the steel industry is in the early stages of major structural change, precipitated by the adoption of new technologies. Thin slab casting is opening up large segments of the world market for light flat-rolled products to electric-arc furnace steelmaking. In fact, electric furnaces are expected to account for about 80% of new steelmaking capacity on a worldwide basis. More than 4 mn tonnes of thin slap capacity is already in service, most of which is operated by Nucor in the United States. By 1998 this figure is expected to exceed 20 mn tonnes, with about two-thirds of the capacity located in North America. Most of the new capacity will be installed by mini-mills, although several integrated mills are also investing in this technology.

The principal advantages of thin slab casting over traditional integrated sheet steelmaking are substantially lower capital costs, speed of construction and ease of incremental expansion. By making sheet steel products more competitive, material substitution may slow further and, in some cases, even be reversed. However, the rapid growth in thin slab capacity probably will set the stage for substantial rationalization of existing, high-cost flat-rolled capacity. The introduction of EAF-based Steckel mill technology will have a similar impact on the production of coiled plate.

Consequently, the producers and sellers of ferroalloys are likely to experience considerable shifts in their steel-related customer base and probably also in the types and qualities of ferroalloys required. The issue of ferroalloy quality standards from the perspective of the steel industry is the subject of another paper. Suffice it to say that product quality, consistency and technical support are of growing importance in all major ferroalloy consuming industries and are a critical aspect of longer-term supply relationships. Ferroalloys that do not meet strict quality standards increasingly can only be sold at substantial discounts. In fact, one of the principal challenges facing many ferroalloy producers, especially in the former East Bloc countries, is to improve product quality and consistency. In many cases, installation of refining equipment and new process control and product handling systems may be required. It also may be necessary to develop new raw material sources.

Many of the factors that influence the ferroalloy markets are beyond the control of individual participants. However, the potential for improved profitability in the manufacture of ferroalloys is linked partly to understanding and meeting customers' needs and to identifying and pursuing specific business opportunities. Financial performance depends not only on cost competitiveness, but also on marketing efforts and on the commercial policies adopted.

In conclusion, improved market fundamentals will secure the financial viability of most ferroalloy operations, while refocusing consumer attention on price stability and longer-term security of supply. The change in outlook may help bring about a more level "playing field" between ferroalloy sellers and buyers.

REFERENCES

1. Webster's New Collegiate Dictionary, G&C Merriam Company, Springfield, Massachusettes, USA; 1979