Vertical integration as a source of competitiveness: The case of ferrochromium in southern Africa

by I. A. Mutemererwa* and M. Ericsson†

Synopsis

This paper investigates the role of vertical integration between chrome ore mines and ferrochromium smelters in the location of ferrochromium production capacity in South Africa and Zimbabwe. Vertical integration is important in understanding the increasing competitive position of these two countries as observations show that an increasingly larger share of the global market has been coming from integrated producers. The paper argues that the increased vertical integration between mines and smelters in South Africa and Zimbabwe has led to a lower cost of chrome ore as an input compared with other producers. Underlying this hypothesis is the basic tenet that, more likely than not, production will take place where the costs are lowest. The paper concentrates on high carbon ferrochromium (HCFC) production in market economy countries (MEC). Using an ordinary least squares model, the study tests the relationship between low chrome ore costs and vertical integration shows a statistically significant relationship. These findings partially support the view that the control of sources of chrome ore is a major source of competitiveness.

Keywords: competitiveness, ferrochromium (ferrochrome), ordinary least squares, dummy variables, vertical integration, southern Africa.

Background

For a long time, up to the 1970s, most chromium was imported into the ferrochromium consuming countries as chrome ore and transformed into ferrochromium, the major source of chromium units in stainless steel making[1]. In 1970, for example, only about 30 per cent of total ferrochromium production was in the ore producing countries. Non-ore producing, stainless steel making countries accounted for the corresponding balance (Pariser[1991]). Since then, there has been a tremendous shift in the production of ferrochromium from the non-ore producing countries to the ore producing ones. This is especially noticeable in southern Africa where both South Africa and Zimbabwe have become significant producers of ferrochromium.

Figure 1 illustrates this shift in ferrochromium production by geographical region. Southern Africa's share rose from 16% in 1970 to almost 60% in 1995 at the expense of almost every region. Why has there been this shift in the production of ferrochromium from non-ore producing countries to ore producing countries, especially the ore producers of southern Africa?

There are a number of possible explanations behind this shift. Technological changes in the stainless steel sector, for example, which have made it possible to process ores of lower quality, making it more profitable to introduce ferrochromium smelters close to mines and the cost of energy are some of the factors (Mutemererwa[1998b]) are some of the reasons. Vertical integration is another. This paper focuses on vertical integration between mines and smelters as a possible cause of this shift, which has been particularly marked in South Africa and Zimbabwe.

Southern Africa's ferrochromium industry: Salient points

According to various estimates[2], about 95 per cent of the economically exploitable ore reserves in the market economy countries are found in southern Africa. South Africa's Bushveld Igneous Complex (BIC) possess about 80 per cent of the global total and Zimbabwe's Great Dyke, accounts for another 15 per cent. The region's dominance in terms

[1] Chromium has three broad uses: metallurgical, chemical and refractory. Ferrochromium falls under the metallurgical industry which consumes over 85 per cent of all chromium by weight (Denler[1990]) and is used as an alloy of addition in stainless steel production

[2] These figures were obtained from the interviews with the producers themselves

* *Division of Economics, Luleå University of Technology, S-971 87 Luleå, Sweden and Institute of Mining Research, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe.*

† *Raw Materials Group, P.O. Box 44062, S-100 73 Stockholm, Sweden.*

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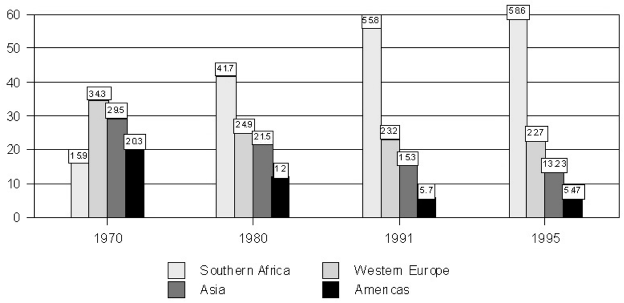

Figure 1—Market economy ferrochromium production (Regional Shares %). Sources: Heinz H. Pariser and USBM

of ore reserves is gradually being mirrored in the production of chrome ore. The region now accounts for about 61 per cent of market economy production. In 1996 South Africa and Zimbabwe accounted for about 56 per cent of global smelter production and installed capacity.

Technological developments during the last fifteen to twenty years have resulted in interesting developments in the ferrochromium industry in Southern Africa, mainly South Africa. The advent of the argon-oxygen-decarburization (AOD) process in stainless steel making resulted in an increase in South Africa's market share in stainless steel making. Analysts note that the largest impact of AOD process on ferrochromium production was in increasing the consumption of HCFC produced mainly from lower grade ores that are found in great abundance in South Africa. The immense growth in South African production has been one of the reasons why the balance of power has shifted towards southern Africa. Table I summarizes some of the main production events during the period from 1970 to 1996.

In the five years between 1975 and 1980 the number of steel plants in South Africa almost doubled and capacity increased by over 60 per cent. In 1975 a completely new company, CMI, was set up to exploit the opportunities presented by the introduction of AOD. As of 1996, it had a capacity of 430 kt (Table I).

Table I

Capacity of southern African ferrochromium producers**

Company	1970	1975	1980	1985	1990	1996
Samancor (South Africa)	55	125	200	240	350	1 115
MS&A (South Africa)	160	160	180	300	420	np
Tubatse (South Africa)	np	120	170	170	170	np
CMI (South Africa)	np	np	120	140	210	430
Purity (South Africa)	np	np	np	np	120	np
Chrome Resources (South Africa)	np	np	np	np	180	250
Hernic (South Africa)	np	np	np	np	np	130
Ferralloys (South Africa)	np	np	80	110	110	150
Zimalloys (Zimbabwe)	50	50	50	np	np	np
Zimasco (Zimbabwe)	40	40	180	180	180	240

** np= not producing
Sources: ICDA (1996), Commodities Research Unit (CRU), Raw Materials Group (RMG) and corporate interviews. The figures represent capacities at each corresponding point in time

In the early 1980s, some fundamental changes took place on the regional scene. In Zimbabwe, Zimasco had become the sole HCFC producer after Zimalloys shifted focus to low carbon ferrochromium (LCFC) and ferrosilicon-chromium. By 1996 Zimasco had expanded capacity to 240 kt (this included some recovery of metal from slag). In South Africa, Samancor consolidated by taking over Tubatse Chrome in 1986 and by acquiring MS&A in 1991. By 1991 Samancor was the largest ferrochromium producer in the world. As can be seen in Table I, Samancor is the dominant producer with a capacity of over 50 per cent of the southern African total. This actually adds up to about 25 per cent of MEC production. Another producer, CMI also consolidated by acquiring Purity Chrome in 1991.

The expansion of production capacity in South Africa meant that production of chrome ore met both domestic and international demand requirements. Until 1982, South African producers exported more chrome ore than was consumed domestically. Continued expansion in domestic ferrochromium production capacity has led to a gradual reversal of this trend. South Africa remains the world's largest exporter of chrome ore. Yet the exported proportion is much smaller compared with local consumption. A scrutiny of the data shows that the exported proportion is getting progressively smaller. Most of the recent capacity additions in South Africa are located at or quite close to the chrome ore mines.

Output from southern African producers is consumed internally, mainly in South Africa and externally in the traditional markets of North America, western Europe and south and east Asia. Trading quantities and prices are negotiated quarterly. In western Europe and North America, negotiations tend to be on a customer by customer basis. There is also a fairly large amount of spot trading, especially in North America. The Japanese merchants, however, tend to negotiate as a team and sellers have to go through the major trading houses such as Mitsui, Mitsubishi, etc. By and large, the prices reflect supply and demand situations and tend to equalize across markets.

An important feature of the market in the late 1980s and early 1990s, has been South African producers, especially Samancor, using their dominant position to increasingly operate as swing producers. This was a strategy employed in 1991/92 when a sudden flood of exports from the FSU led to a collapse in the price of ferrochromium (as with those of most metals). Production was cut down to, in some cases, 25 per cent of capacity[3].

The most outstanding feature, by far, of the production of ferrochromium in southern African has been the increasing level of vertical integration. Mergers and take-overs consolidated the ownership links between mines and smelters. The entry of Hernic and Chrome Resources, who had started out as chrome ore producers only, further confirmed this trend towards vertically integrated production. The integration was both backward and forward. In certain instances smelters acquired mines and in others mines acquired smelters.

[3] Samancor Company Annual Reports, 1992 to 1994

Vertical integration in the literature

Vertical integration occurs when two firms 'that merge produce output or supply services that are used in successive stages of production' (Weiss[1992]). There is a substitution of internal transactions for market or contractual exchange. This results in a new organization where both parties benefit from this way of organizing production.

Analysts indicate that the most significant explanation for vertical integration is security of supply of certain key inputs. Why should this be so, when the market is supposedly competitive enough to ensure supply? Coase[4] (1973) observed that production decisions could be organized, either by price movements and by a complex series of market transactions outside of a firm, and governed by contractual obligations between the downstream firm and its upstream counterparts, or by an 'entrepreneur-coordinator' within one firm (Carlton and Perloff[1994]). The main difference lies in where these transactions (or decisions) actually take place; 'administratively within one firm' or 'contractually between different firms'.

The 'neo-classical' approach focuses on the market power in the intermediate (or input) market rationale, implying a divergence between the value of its marginal product and its marginal cost. This divergence would be, mainly, a result of market imperfections. Therefore a firm in the intermediate market earns economic rents arising out of a monopolistic position or quality of the product (Ricardian rent). Alternatively the firm could be earning quasi-rent, which would gradually be competed away in a market where there are no long-term barriers to entry. If this difference can be eliminated, by merging the activities of the two firms, this would result in an increase in the profits of the combined organization (Spiller[1985]). Additions to this neo-classical approach have included uncertainty in the provision of the intermediate (upstream) product (Arrow[1975]) or simply taking advantage of economies of scope between successive stages of production.

Vertical integration is also analysed through the transactions approach. This approach, popularised by Williamson[1979,1985], Klein, Crawford and Alchian[1978] is often described in literature as the K-C-A approach. This follows from the opportunistic hazards of investing in a specific asset, which has little or no value outside of this vertical relationship. For example, when a downstream firm faces increasing demand for its product and the firm is completely dependent on one particular supplier, that supplier may take advantage of this opportunity and raise its prices. This situation can still arise, even when foreseen *ex-ante*, as structuring a contract such that the opportunism is eliminated, may not be possible. Vertical integration would, therefore, be a way of eliminating the transaction costs associated with drafting a complete contractual relationship.

This paper concentrates on the neo-classical approach for relevance to the ferrochromium industry. Here it may help to list the salient points of this school of thought.

- By vertically integrating backwards a firm can secure for itself an uninterruptable supply of key input(s). Hence a ferrochromium-smelting firm, for example, would acquire chrome ore mines in order to secure supplies, especially in an uncertain environment. This is linked to the earlier thinking behind the transaction cost thesis, when in order to minimize the chances of being a victim of input supplier, firms took over such suppliers. Within a neoclassical setting, however, wider issues such as market failures or externalities form the basis for integration—'if you want something done right, do it yourself' (Carlton and Perloff[1994]).
- Firms can vertically integrate for strategic reasons, especially in imperfect markets where there is a divergence between the market price of the intermediate good (chrome ore) and its marginal cost. The motivation would be the elimination of this difference after integration, to the advantage of the new organization. This can also lead to a firm gaining market power (and market share) through its reduced costs of production.

From these two neo-classical arguments, the strategic rationale is the most intuitively appealing for the ferrochromium industry. The differential between the marginal costs and price of the input confers immediate benefits to the integrated firm in the form of lower input costs. The price-marginal cost differential also means the market for the chrome ore is an imperfect one, characterised by monopolistic competition. Theoretically, there is always the possibility that the firm being targeted for take over would include the expected value of economic rent in the price at which it would be willing to be taken over. This would most likely occur where the upstream is earning monopoly economic rent or profits. This may not be the outcome especially when the rents being earned are merely quasi-rents or where the upstream firm starts its own downstream subsidiary.

Although a valid justification for vertical integration, the argument for securing essential supplies will not be pursued here. This is because the main idea behind competitiveness lies more in reducing production costs through removal of the price-cost margin of inputs than in reducing uncertainty of supply.

Strategic motives, therefore, revolve around not only appropriating this price-marginal cost difference but, sometimes also to raise rivals' (or potential rivals') costs. This can be done through causing entry costs in a foreclosed market to increase since to enter it, investment would have to be undertaken in both the upstream and downstream industries simultaneously. This would entail not only setting up a smelter but also acquiring minerals rights and opening up a captive mine. This, however, seems to be an extreme case, and the evidence shows that there are some non-integrated mines and smelters still to be found.

Of the merger itself, there are two possible effects, depending on the post-merger market structure. In a classical, competitive market, *ceteris paribus*, the price of the ferrochromium will fall in response to the fall in the cost of production. The results in an imperfect market, however, are much less clearer, and depend on two countervailing forces.

Firstly, if the resultant structure of the market is a monopolistic one, from a previously competitive one, there is likely to be an increase in the price of the final good

[4] Quoted in Grossman and Hart[1986] and Carlton and Perloff[1994]

(ferrochromium), as a direct result of the monopolization of production. With the price-marginal cost differential of the input removed, however, there would also be a reduction or a tendency towards a reduction in the price of the upstream product. How far the price actually goes up or down depends on the net effect of the two forces. An integrated firm would be able to gain market share, at the expense of non-integrated firms, by being able to lower its prices and selling higher volumes. It should be remembered that the monopolist (or oligopolist in this case) is only able to manipulate one of two variables—price or quantity. Perry[1978] has shown that, generally, vertical integration (in his case backward integration by a monopsonist) induces the new firm to expand its consumption of the input. He has also shown that generally, but not always, consumers of the final product tend to benefit from lower prices arising from the removal of the 'rent component' of the input costs.

The reduction in production as a result of the reduction of the price-marginal cost differential of the chrome ore for an integrated producer is an important point to note here. Reduced production costs in an imperfectly competitive market should allow for the formulation of a testable model to explain the favourable shift in competitiveness for vertically integrated southern African producers.

Vertical integration in the southern African ferrochromium industry: An empirical analysis

A survey of current producers in southern Africa of commodities analysts, both in southern Africa and in Europe[5], was undertaken to determine the reason for vertical integration in the chrome industry and as a result explain why the shift to southern Africa has occurred as the region's market share has increased.

Table II shows the share of the cost of chrome ore in the total cost of production for a typical South African producer.

As can be seen, chrome ore and electricity are the major cost components. Data show that chrome ore is the single largest cost for a typical South African producer. Despite the obvious importance of electricity costs, this paper focuses on the impact of chrome ore costs in industry location.

Table II

Main cost items in HCFC production (typical South African cost per lb Cr)

Cost Item	1988 US cents	Share %
Chrome ore	9.0	35
Electricity	8.0	31
Labour	4.8	18
Reductants	2.6	10
Others*	1.5	6
Total ex-works	25.9	100

* fluxes, binders and electrode paste
Sources: Heinz H. Pariser and CRU (1991)

It is arguable that anything that results in the reduction of the cost of chrome ore reduces total costs, *ceteris paribus*. The extent of reduction depends on the initial change of chrome ore costs. Southern African producers surveyed for this paper noted that by securing their ore at about its marginal cost, they were paying between 20 and 40 per cent less than non-integrated producers. This implies that by integrating vertically, smelters were most likely able to get the ore at marginal cost since the firm would generally choose where to make its money. In this scenario mines become subsidiaries.

How would the monopolistic nature of the chrome ore market arise? It has already been noted that over 90 per cent of the resources are in southern Africa. Further, only a few companies own the most easily exploitable reserves, in both South Africa and Zimbabwe, mostly through complex mineral rights policies.

There is another angle to the vertical integration story. This has been called 'raising rivals costs' in the literature, where independent producers of ferrochromium face a quantity squeeze, as more and more production of chrome is consumed in-house by integrated producers. The extreme case would be total market foreclosure, in a case where they would have to close down for lack of inputs. This case is not very relevant in the ferrochromium market, since there are still a number of non-integrated chrome ore producers who can be called upon to supply the shortfall[6]. Most of these non-integrated chrome mines tend to be marginal producers. Yet they are profitable at high prices (of ore). Still, there is an element of foreclosure in this, since most of the non-integrated ferrochromium producers would be forced to turn to these marginal suppliers.

Further, most of the chrome ore exported from southern Africa comes from South Africa. The bulk of this is of chemical (and hence lower) grade and tends to require more beneficiation to make it suitable for metallurgical purposes, adding further to the costs of the non-integrated smelter. Even more importantly as the South Africans expand their ferrochromium production their surplus ore production (available to non-integrated producers) is reduced correspondingly—a kind of creeping foreclosure.

The main result has been that most of their (southern African) non-integrated competitors have found themselves caught between two fairly difficult positions. Firstly, they cannot expand without significantly raising their costs of production. Secondly, they face reduced prices for their product, as a result of the under-cutting integrated producers. A survey of southern African producers showed that in the long run they are better placed to meet future increases in demand if the stainless steel industry continues to grow at the rates at which it has grown historically than others elsewhere. Respondents believe that they will continue to capture market share away from non-integrated producers even in a stagnant market. Some evidence of this comes from some former Japanese producers (Nippon Steel and JMC) who have 'closed shop' in Japan and migrated to southern Africa establishing joint ventures with existing producers there. In

[5] In Europe, CRU and Heinz, H. Pariser. In Africa, Standard Bank and Societe General Frankel Pollak and JCI and all the producers listed in Table I

[6] In Zimbabwe, most of the chrome claims are owned by Zimasco and Zimalloys who do not export ore

return they have brought into these ventures new and improved smelting technology and access to their customers.

These interviews confirm the hypothesis that vertical integration took place mainly to reduce the costs of production. Based on this confirmation, an econometric model to test the hypothesis that increased vertical integration has led to lower chrome ore was formulated where chrome ore costs as a dependent variable and a 'dummy' binary variable which distinguishes vertically integrated producers from non-integrated ones as the explanatory variable.

The following is the simple model to be tested:

$$CHR_i = \beta_0 + \beta_1 D_1 + \varepsilon_i \qquad [1]$$

where CHR_i = the unit cost of chrome ore for producer i,
D_i = a dummy variable, 1 for a vertically integrated producer, 0 for a non-integrated one.
ε_i = a random error term, which is assumed to have a mean of zero and a constant variance.

Basic to the concept, the model is a comparison of two means, in this case of chrome ore costs, coming from two groups with [perceived] different characteristics. In this case the two groups are integrated and non-integrated producers. From Equation [1] the expected cost of chrome ore for producer i, CHR_i given that the producer is non-integrated is β_0, given that $D_i = 0$. This becomes $\beta_0 + \beta_1 D_i$ for an integrated producer, since $D_i = 1$. From the hypothesis, β_1 is expected to be negative, giving the following inequality: $\beta_0 > \beta_0 + \beta_1 D_i$; making β_1 the difference between the expected chrome ore costs of the two groups. This is to say, that one expects the chrome ore costs of a non-integrated producer to be higher than those of an integrated producer.

The model was tested on a sample of 18 producers including some from outside southern Africa. The unit of observation still remains the individual firms. These firms account for about 71 per cent of MEC production.

The data used are derived from a 1995 cost study done by Heinz H. Pariser, a commodities analyst firm, specializing in steel and its alloying metals. The costs studies that they produce are based on data from different sources, mostly company annual reports, personal interviews and trade literature. The information so gathered is subjected to various estimations and simulations to come up with the final costs of production. Although the figures may not coincide with what economists term as costs, they are widely accepted by the industry to be as good approximations as any.

The model was run using conventional OLS and the following results were obtained. The t-values are in brackets below each coefficient.

$$\begin{aligned} CHR_i = \ & 18.18 \ - \ 8.96 D_i \\ & (17.11) \quad (-5.57) \end{aligned} \qquad [2]$$

$$R^2 = 0.69$$

The sign for the coefficient of D_i is negative, as expected. Its t-statistic shows that it is significant at the 5 per cent level of significance, using a two-tailed test. The R^2 -statistic of 0.69 shows a rather good coefficient of joint determination, especially for cross-sectional data (Studenmund[1992], p. 47). The coefficient for the dummy variable shows that the expected cost per pound of chrome ore is lower, in this case about 9 US cents lower, for a vertically integrated producer than for a non-integrated one. These results largely confirm the theoretical base upon which this paper is based and provide support to the findings of the surveys.

These results confirm that a relationship between vertical integration and lower chrome ore cost exists. The hypothesis of vertical integration as a means of reducing the costs of production, and therefore to enhance competitiveness cannot be rejected both by this simple regression model and by the interviews.

Discussion and concluding comments

The paper investigated the reasons for vertical integration in the ferrochromium industry and its link with competitiveness. The results confirmed the relationship between chrome ore costs and vertical integration and provide partial support for the view that vertical integration leads to lower input costs. From these results it can be concluded that the motive for the vertical integration in the southern African ferrochromium industry has been to lower costs.

The results provide partial support for the thesis that vertical integration has been a major source of competitiveness, measured as a gain in market share, in the production of ferrochromium in southern Africa. The region has lower costs compared with its competitors. The two approaches employed to test the hypothesis reinforced each other. The econometric test establishes the negative relationship between the expected cost of chrome ore and vertical integration and supported the reasons given by the company executives as the basis for vertical integration. Earlier in this paper the importance of chrome in the structure of costs was established. Therefore, lowering the costs of chrome would be one significant way of achieving competitiveness.

Based on this, some tentative conclusions can be reached. The trend in ferrochromium production seems to point to an even further shift to southern Africa as the region is the largest source of chrome ore reserves. The possibility of low chrome ore costs through vertically integrated production seems to be one of the factors making this possible. Hence, if the case established above holds, the region is expected to further increase its market share to reflect its resource base with any new capacity being located ever closer to the ore. The fact that other former producers from non-producing countries such as Japan are prepared to relocate to southern Africa seems to offer further evidence of this. The case of the Japanese producers is especially instructive as all of them are part of stainless steel conglomerates, who have shielded them from their uncompetitive cost position for a long time. There seems to be a general belief that the high import tariffs were also important in shielding them from competition (Pariser[1995]).

The focus of this paper has been deliberately narrow: vertical integration and through it the cost of chrome ore as a source of competitiveness. Narrowing the approach allowed us to isolate *one* of the important factors in competitiveness. The main point to come from this paper is that vertical integration has been important in the relocation of ferrochromium smelting capacity to countries such as South Africa and Zimbabwe. These developments reinforce the notion of the market power being an argument for vertical integration, to the extent that the lowering of costs gives a firm an opportunity to get additional market shares.

It must be noted that the results of this paper only explain part of the story since there appears to be some important exceptions to the above rule. Of particular note is the competitiveness of producers in Norway and Sweden who are non-integrated and producers in India and Brazil who are integrated. Caution should be taken in the interpretation of these results by region. One should not conclude that possession of ore, by itself, is the pre-requisite for competitiveness. It has already been pointed out that there are other cost factors that could influence location decisions.

Increase vertical integration in ferrochromium production is at odds with what has been happening in the iron ore and steel industries. Instead of more integration, non-integration had remained the norm. Iron ore mining companies have remained largely independent of steel producers. While the characteristics of the iron ore and steel-making industries are beyond the scope of this paper, some things do stand out. One is the large volumes of iron ore that are traded on the market. Further, the actual share of iron ore costs to total costs of steel-making, in contrast to chrome ore and ferrochromium, is rather low at around 5 per cent (Hellmer1997), while, as illustrated in Table II, it is about 35 per cent in ferrochromium. There would be very little scope and incentive for removing any price-marginal cost differentials by the steel firms. These reasons, possibly, explain the differences in the way the two industries have developed although both are 'ferro-alloy' materials. Another reason, perhaps even more important, would be the difference in the two products. Steel is a speciality rather than a commodity and hence there is a tendency for steel plant to be located close to the end use markets.

This paper has shown that a case could be made for vertical integration as a source of reducing input costs in ferrochromium production and enhancing competitiveness in southern Africa.

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