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IRON ORE AND STEEL: A CASE STUDY OF THE ECONOMIC CAUSES AND CONSEQUENCES OF VERTICAL INTEGRATION

by RICHARD B. MANCKE

INTRODUCTION

FUEL, water, and iron ore are the most important inputs used in the production of pig iron; pig iron is the most important input used in the production of steel. Because of the high transportation costs, before 1830 American pig iron producers found it most profitable to locate where these three inputs existed in conjunction.[1] At this time successful pig iron firms were small, sold their product in narrow geographical markets, and produced for their own use most of the necessary raw material inputs. After 1830, as anthracite coal became an economical fuel, as huge geographically concentrated deposits of iron ore were discovered and developed in areas far away from the nation's major population centers, and as the nation's internal transportation improved, sharply increased scale economies arose in the production of both of pig iron's principal mineral inputs. At the same time, the scale economics of pig iron production were increasing at a much slower rate. Thus, most successful pig iron producers began to realize diminishing profits in the production of both iron ore and fuel. Hence, they began to find that it was more profitable to buy both mineral inputs in the market. This realization led to a trend toward less backward integration by pig iron producers (and their successors, the crude steel producers) that continued unabated until the mid-1890s.

Between 1896 and 1900 more than two-thirds of the total iron ore consumed in the United States came from mines located in the Lake Superior region. In 1896 more than one hundred companies were located in this region, and they produced 9,669,000 tons of iron ore. Twenty-six of these companies produced at least 100,000 tons of iron ore and five produced more than 400,000 tons. The combined output of the five largest firms totalled 3,130,000 tons and the largest (the Minnesota Iron Ore Company) produced almost 900,000 tons. Only one of these five companies (the Oliver Iron Mining Company) was owned by a steel producer.[2]

The total iron ore output of the Lake Superior region soared to

[1] Temin (P. Temin, *Iron and Steel in Nineteenth Century America: An Economic Analysis* (Cambridge: M.I.T. Press, 1964) documents the facts summarized in this paragraph.
[2] *Iron Age* (January 14th, 1897, p. 28).

19,059,393 tons in 1900.[3] Nevertheless, Table I shows that only twenty-two firms produced more than 100,000 tons during this year. Moreover, eight steel companies completely controlled more than 74 per cent of this region's total iron ore output, and just three completely controlled 52 per cent of this total.

TABLE I

TOTAL IRON ORE OUTPUT BY ALL FIRMS THAT PRODUCED MORE THAN 100,000 TONS OF LAKE SUPERIOR IRON ORE IN 1900[a]

Company	*Total iron ore output*
Steel companies	
1. Carnegie Steel Company	
a. Oliver Iron Mining Company	4,534,372 tons
b. Lake Superior Consolidated Iron Mines[b]	1,347,268 tons
2. Federal Steel Company	
a. Minnesota Iron Ore Company[c]	2,861,375 tons
3. National Steel Company	1,078,882 tons
4. American Steel and Wire Company	443,622 tons
5. American Steel Hoop Company	200,000 tons
6. Republic Iron and Steel Company 7. Jones and Laughlin 8. Cambria Steel	2,630,000 tons
Independent iron ore companies	
1. Cleveland Cliffs Iron Company	1,011,000 tons
2. Corrigan, McKinney and Company	750,000 tons
3. Aragon and Commonwealth	500,000 tons
4. Pickands, Mather and Company	400,000 tons
5. Ferdinand Schlesinger	360,000 tons
6. Joseph Sellwood Group	325,000 tons
7. Hayes Brothers	223,000 tons
8. Crerar, Clinch and Company	175,000 tons
9. Eddy Brothers	147,000 tons
10. Republic Iron Company	130,000 tons
11. S. S. Curry	125,000 tons
12. Champion Iron Company	114,000 tons
13. Montreal Mining Company	107,000 tons
14. Kimberly Interests	102,000 tons

[a] Source: *Iron Age* (February 14th, 1901, p. 29; February 21st, 1901, p. 13).

[b] Lake Superior Consolidated Iron Mines was owned by the Rockefeller interests. However, in 1896 all of its output was leased to the Carnegie Steel Company for fifty years.

[c] The Minnesota Iron Ore Company merged with the Federal Steel Company in 1898.

Between 1896 and 1900 the sixty-five-year trend to less backward integration by American pig iron and steel producers was dramatically reversed. During this five-year span the largest American producers of pig iron and crude steel became self-sufficient in iron ore. The visible economic structure of the American iron ore industry was

[3] *Iron Age* (February 14th, 1901, p. 29; February 21st, 1901, p. 13).

transformed from an unconcentrated industry composed almost entirely of independent iron ore producers who sold their product over the open market into a concentrated industry where mines either owned or under long-term lease to one of the three largest pig iron and crude steel companies produced over one-half of all Lake Superior iron ore.

The most popular explanation for the pig iron and crude steel producers' sudden and very successful attempt to backward-integrate has been that they expected to earn higher profits by increasing their monopoly power.[4] This explanation suffers from two shortcomings: (1) the failure of its advocates to explain why it was not until 1896 that investors realized that monopoly profits were possible in the American iron ore industry, and (2) their failure to explain why, for the first time since about 1830, iron ore investments were thought more profitable if made by pig iron or crude steel producers rather than by independent iron ore companies.

This paper examines the important events that preceded and coincided with the backward integration into iron ore production (between 1896 and 1900) by pig iron and crude steel producers. First, the paper shows that sharply lower iron ore prices and increased competition coincided with this sudden backward integration. Secondly, this evidence is used to show that the traditional explanation, that this backward integration was for the sake of monopoly profits, is erroneous.

I

By 1890 more than one-half of the iron ore consumed by the American steel industry came from mines bordering on Lake Superior. At this time no American steel companies were producing Lake Superior iron ore—all ore from Lake Superior mines was sold to steel companies on the open market.

In 1892, Andrew Carnegie's Carnegie Steel Company spent almost $1 million to acquire a half interest (later increased to a five-sixths interest) in the Oliver Iron Mining Company. The Carnegie company's purchase of Oliver, a firm owning leases to several iron ore properties on the Mesabi Range, marked the first entry by a steel company into Lake Superior iron ore mining. It is

[4] In addition to Temin (*op. cit.*) this explanation of the steel producers' successful backward integration into iron ore also appears in Department of Commerce, Bureau of Corporations, *Report of the Commissioner of Corporations on the Steel Industry*, Part I, 'Organization, Investment, Profits, and Position of the United States Steel Corporation' (Washington: U.S. Government Printing Office, 1911); Gabriel Kolko, *The Triumph of Conservatism: A Reinterpretation of American History, 1900–1916* (New York: Free Press, 1963); H. Livesay and P. Porter, 'Vertical Integration in American Manufacturing, 1899–1948', *The Journal of Economic History*, September 1969, pp. 494–500.

noteworthy that there exists no evidence that either Carnegie's competitors or contemporary industry observers attached special significance to this event. There are two explanations for their indifference. First, Mesabi Range producers had shipped only the minuscule total of 4245 tons of iron ore in 1892. Secondly, at the time of this purchase, neither unusually high profits nor monopoly power were expected to accrue to iron ore investors.

Immediately after the Carnegie company began to produce Mesabi Range iron ore, Range output soared. However, although total iron ore output from the Mesabi Range reached 2,760,000 tons in 1895, the annual supply of ore from the Oliver investment remained 'small in comparison with the Carnegie company's total requirements'.[5] At this time Oliver was not one of the largest producers of Mesabi Range iron ore.[6] Moreover, 'Mr. Carnegie is said to have been decidedly opposed to the ownership of ore mines; . . . instead he preferred to let others assume the heavy speculative risks which then attended iron mining enterprises.'[7]

Even though the level of operations of the Carnegie company's Oliver affiliate remained economically insignificant, dramatic changes were taking place in the American iron ore industry. High-quality ore from the Mesabi Range proved more abundant and less costly to mine than similar ore from the established Lake Superior ranges; hence, its output soared. By 1895, a mere three years after the small initial shipments, almost 25 per cent of all Lake Superior iron ore shipments originated in the Mesabi Range. This huge increment in the annual supply of low-cost iron ore coincided with falling steel production and, therefore, slumping iron ore demand. The inevitable consequence was a sharp break in iron ore's price.

In 1894 the one-year contract price of Bessemer grade (very high quality) iron ore at a lower Lake Erie port was at most $2.75 per ton. The producers of Lake Superior iron ore (except those whose ore came from the Mesabi Range) thought that this price compared unfavorably with the $6.00 per ton price similar ore had fetched only three years earlier. Predictably, since the new low-cost iron ore source threatened their very existence, the higher cost producers issued a torrent of indignant complaints. They also took the more practical step of establishing an iron ore pool. The pool members agreed to restrict output in order to stem and hopefully to reverse the

[5] *Report of the Commissioner of Corporations on the Steel Industry*, p. 68.

[6] According to the *New York Times* (12/16/95) of the total 2,760,000 tons of Mesabi Range iron ore output in 1895, the Minnesota Iron Ore Company mined 825,000 tons, Rockefeller's Lake Superior Consolidated Iron Mines mined 525,000 tons, and the remainder was mined by smaller firms, including Oliver, classified as independents by *The Times*.

[7] *Report of the Commissioner of Corporations on the Steel Industry*, p. 68.

trend to lower iron ore prices. Unless the members of this pool offered a sufficient reward to entice the low cost producers of Mesabi Range iron ore to join, it was inevitable that the pool's price-raising efforts would be thwarted. Because they failed, the owner–manager of one large iron ore company offered this melodramatic but accurate description of the quandary faced by the non-Mesabi Range iron ore producers in early 1895.

> We sobbed at the sight of wealth as great as that of the Rothschilds vanishing into mist, all through the discovery of ore fields from which can be mined more ore than the whole world needs. This is all due to the development of the Mesabi Range and the billions of tons of ore which can be placed on the [railroad] cars at a low price and assure the world of an adequate supply of the mineral for a thousand years.[8]

Because the producers of high-cost iron ore failed to persuade the producers of Mesabi Range iron ore to collude, the delivered spot price of iron ore fell to about $2.50 per ton during the first four months of 1895. This price was so low that only producers of low-cost Mesabi Range iron ore earned profits.[9] Then the ever-cyclical American steel demand soared. This led to a sharp rise in iron ore demand which, because of short-run bottlenecks in both mining and shipping Lake Superior iron ore, could only be satisfied at sharply higher prices. Because of this fortuitous event, at the close of the 1895 Great Lakes' shipping season, the delivered spot price of iron ore was at least $1.60 per ton above the level of seven months earlier.[10]

One consequence of iron ore's sharp scarcity-induced price rise was that many entrepreneurs decided to make new investments to overcome short-run production and transportation bottlenecks. The most controversial of these investments was John D. Rockefeller's. In the autumn of 1895, he announced that he would build a large fleet of ore boats in order to guarantee low cost shipping for his Mesabi Range ore to its point of sale at the lower Lake Erie ports. Many established shippers warned that Rockefeller's move demonstrated his desire to monopolize Great Lakes' iron ore shipping. Largely because of Rockefeller's reputation as a rapacious monopolist, this has remained the accepted explanation. Since, if implemented, Rockefeller's shipbuilding plans would have increased rather than decreased the capacity (and output) of the Great Lakes

[8] *New York Times*, February 28th, 1895.

[9] Even when the delivered spot price of iron ore was at $2.50 per ton the producers of Mesabi Range iron ore were investing to expand output. This suggests that they thought that iron ore produced in the Mesabi Range could be profitably sold at this price.

[10] *New York Times*, December 16th, 1895.

iron ore shipping industry, in all probability, the real cause of the established shippers' protests was an attempt to forestall the lower prices and therefore lower profits that would accompany the entry of a new large competitor.

A second consequence of iron ore's sharp scarcity-induced price rise occurred in March 1896, when the 'high cost' iron ore producers agreed that conditions were sufficiently favorable to empower them to maintain the price of Bessemer grade iron ore delivered to lower Lake Erie ports at the 'barely adequate' level of $4.00 per ton. However, since the members of this new ore pool also failed to persuade the producers of Mesabi Range iron ore to join, the test of whether or not the pool was effectively exercising monopoly power would not take place until either (1) the short-run constraints on the production and shipment of the low cost Mesabi Range iron ore had been circumvented or (2) iron ore demand fell. More specifically, since the long-run total cost of producing Mesabi Range iron ore remained at about $2.50 per ton, if after its short-run scarcity had been alleviated the price of iron ore remained at or near $4.00 per ton, one can conclude that the pool members had indeed exercised significant monopoly power. If, instead, the price of iron ore fell to the much lower long-run competitive level of about $2.50 per ton, one can conclude that the pool was ineffective. Part II of this paper demonstrates that the available evidence supports the second conclusion.

A third consequence of iron ore's sharp scarcity-induced price rise occurred in December 1896, when Andrew Carnegie's steel company agreed to purchase a fifty-year lease to the entire output from John D. Rockefeller's large Mesabi Range iron ore properties. In commenting on the economic significance of this transaction the editors of *The Engineering and Mining Journal* stated:

> The situation in the steel market is now practically that the Carnegie company controls its own supply of ore. . . . With its enormous plant, to which all the latest improvements and economies have been added, and with its raw materials practically furnished at bare cost, this company is not only in a position to make steel cheaper than any other producer; it is so situated as to be absolutely in control of the market, and make the prices of steel what it will. We have had pools and combinations without number in the iron market in this country, but never before a position like this in which a single company could absolutely dominate the trade and make any combination which can be formed simply the register of its own wishes.[11]

[11] *The Engineering and Mining Journal*, January 2nd, 1897.

This statement admirably summarizes the popular tale that the Carnegie–Rockefeller iron ore transaction was a brazen (and some felt successful) attempt by Carnegie to gain monopoly control over the United States' iron ore industry. Moreover, the tale continues, Carnegie's competitors in the steel industry feared the high ore costs that they would certainly face if he succeeded. Thus inexorable economic pressure forced them to follow his lead and to begin to integrate backwards into the production of iron ore. We will ignore for the moment the real cause of the crude steel producers' backward integration. Here we shall be content with reiterating that by 1900, only four years after Carnegie began to actively pursue backward integration, more than 74 per cent of the Lake Superior region's total iron ore output was from mines owned or under long-term lease to the largest steel companies. This fact confirms that a dramatic change had been wrought in the visible economic structure of the Lake Superior iron ore industry.

II

The foregoing discussion documents the fact that throughout 1896 the steel companies were paying relatively high prices for iron ore.[12] Obviously it was in the self-interest of any steel company (provided the cost was sufficiently low) to destroy any actual or potential iron ore monopoly in order to guarantee lower iron ore costs once the short-run scarcity was alleviated. The following discussion demonstrates that Andrew Carnegie's leasing (December, 1896) of John D. Rockefeller's iron ore properties coincided with and helped to end the belief that an effective iron ore pool could survive.

In 1895, the iron ore properties that the Carnegie company subsequently leased for fifty years from Rockefeller's Lake Superior Consolidated Iron Mines Company produced 525,000 tons of low-cost iron ore; the mines produced more in 1896. At the start of 1895 ore from these mines sold profitably at a price no greater than $2.50 per ton. During 1896 the same quality ore was sold at $4.00 per ton. Thus we infer that if Rockefeller had been confident that the iron ore pool would succeed in its efforts to maintain the $4.00 per ton price for iron ore, then he would have demanded a price for his Mesabi Range leases that was at least equal to the present value of a royalty of $1.50 per ton on his mines' expected iron ore output in each of the next fifty years.[13] The actual terms of the lease (a $600,000 bonus

[12] In 1896 the reigning iron ore prices were far greater than the long-run marginal cost of producing Mesabi Range iron ore.

[13] $1.50 is equal to the difference between the 'expected' price, if the ore pool was successful, of $4.00 a ton and $2.50 a ton, the upper-bound estimate of this ore's real unit

paid over several years and a royalty of $0.25 per ton paid on each ton shipped) were nowhere near this amount. Unless Andrew Carnegie duped the reputedly shrewd Mr. Rockefeller, these modest terms constitute evidence that tends to refute the traditional belief that this transaction was undertaken because it would enable Carnegie to establish monopoly control over iron ore.[14] Indeed, the low sum paid by the Carnegie company for these leases provides ample grounds for suspecting exactly the opposite. That is, the Carnegie–Rockefeller agreement at the most caused and at the least merely confirmed that there had been a rapid erosion in the anticipated future price of iron ore. Additional evidence supports this suspicion.

In early 1897, shortly after the announcement of the Carnegie–Rockefeller iron ore transaction, the members of the 'successful' iron ore pool of 1896 met to set the new season's price of Bessemer grade iron ore. They agreed that because of the imbalance of supply and demand it would be impossible to maintain this price at the previous year's 'barely acceptable' level of $4.00 per ton. Instead, the pool publicly announced that it would try to maintain a price of $2.75 per ton. The timing of this sharp price cut supports the thesis that, contrary to the traditional interpretation, the Carnegie–Rockefeller ore agreement marked the erosion (not the enhancement) of the pool's prospects for achieving a successful iron ore monopoly.

If the Carnegie–Rockefeller iron ore agreement really marked the end of the belief that iron ore producers possessed sufficient monopoly power to successfully maintain the price of iron ore at a level far above the cost of producing low cost Mesabi Range ore, then one would also expect to observe that there was a sharp fall in the price of iron ore properties. The contents of a letter written in mid-1897 by Henry Oliver, the manager of the Carnegie Steel Company's iron ore properties, to Carnegie's associate, Henry Frick, confirms that the Carnegie–Rockefeller transaction did indeed coincide with a sharp fall in the price of iron ore properties. Oliver wrote:

> I desire to impress upon you the fact that if it had not been for our Rockefeller–Mesabi deal of last year, with the consequent

cost. The royalty would need to be greater than $1.50 a ton if in addition to the expected rents Rockefeller were also compensated for previous exploration and development expenditures.

[14] At the time of this sale some industry observers stated that Carnegie had agreed to purchase Rockefeller's iron ore in order to prevent (i.e., bribe) him from building a 'giant' steel plant in South Chicago. If this were true, one would expect that an astute 'Robber Baron' like Rockefeller would have gained more than Carnegie from their iron ore deal. Since this story suggests that Rockefeller actually enjoyed a stronger bargaining position than Carnegie, the terms of the lease make it very difficult to escape the inference that Rockefeller thought it to be quite unlikely that in the future very high monopoly profits would accrue to the producer of his iron ore.

> demoralization in the trade caused by the publication thereof, it would not have been possible for us to now secure the other Range properties I propose to acquire, either by lease or for any reasonable price. We simply knocked the price of ore from $4 down to, say $2.50 per ton. Now let us take advantage of our action before a season of good times gives the ore producers strength and opportunity to get together by combination.[15]

Oliver's letter shows that the price of both iron ore properties and iron ore fell following the Carnegie–Rockefeller agreement. The letter also suggests that Oliver felt that the 'demoralizing' price fall made the independent ore producers more pessimistic than he about future prospects for profits on iron ore investments. Only this could explain why he judged it so attractive to purchase additional iron ore mines at the new reigning prices. Oliver's success in persuading Andrew Carnegie of the wisdom of this position is attested to by the fact that Carnegie's Oliver Iron Mining Company purchased two more large iron ore properties before the end of 1897. Because of these additional purchases, the nation's largest steel company was self-sufficient in iron ore by the end of 1897.

In 1897, the other large crude steel producers followed the Carnegie company's lead and began to purchase Lake Superior iron ore mines. The largest purchase was the acquisition in 1898 of the Minnesota Iron Ore Company by Carnegie's largest competitor, the Federal Steel Company. The traditional explanation for this successful attempt by Carnegie's rivals to backward-integrate asserts that they wanted to 'protect' themselves from the high monopoly ore prices that threatened them if Carnegie succeeded in his attempt to gain control over most of the nation's iron ore supply. Another possible explanation is that for the first time since about 1830 the owners and managers of these steel companies recognized that real economies would accrue to those companies that produced most of their own iron ore.[16] Obviously, if either of these explanations is correct, steel companies would have increased demand for iron ore properties. *Ceteris paribus*, increased demand would have led both to a rise in the market value of those properties not purchased by the Carnegie company and to a rise in the price of iron ore. Because the price of iron ore and the value of the remaining Lake Superior iron ore properties (1) fell sharply following the Carnegie–Rockefeller

[15] *Report of the Commissioner of Corporations on the Steel Industry*, p. 77.

[16] No one has ever presented any evidence that real economies would have resulted if the steel companies had produced their own iron ore. Moreover, the fact that the steel companies frequently subcontracted to others the actual management of their iron ore properties suggests that this is an unlikely explanation of the cause of the vertical integration.

iron ore transaction of 1896 and (2) remained at this much lower level for several years, neither explanation can account for the observed rapid backward-integration by Carnegie's rivals into the production of iron ore.

There is only one simple explanation that is consistent with the simultaneous occurrence of the steel companies' rapid backward-integration and the sharply falling prices for both iron ore properties and iron ore. That is, that many of Andrew Carnegie's steel-making rivals, like Carnegie himself, were less pessimistic about the trend of future iron ore prices than were the debt ridden owners of what had suddenly become much less valuable iron ore properties. Only if this were the case would one expect to observe the simultaneous occurrence of these two phenomena: (1) steel companies actively buying most known iron ore properties and (2) the prices of these properties, and of iron ore, continuing to remain near their historic low.

III

Between 1896 and 1900 the visible economic structure of the American iron ore industry experienced dramatic change. In just five years it was transformed from an industry composed of many small independent (i.e., not affiliated with steel companies) firms into a highly concentrated industry with most of its output produced by subsidiaries of the largest steel companies. Because the foregoing discussion has established that these events coincided with sharply lower prices for both iron ore properties and iron ore, it would seem to be incorrect to infer that this dramatic structural transformation led to increased monopoly power for the producers of iron ore. Indeed, since the steel companies' successful attempts to vertically integrate coincided with, and probably caused the end of, attempts by the independent iron ore companies to establish iron ore pools, it is more likely that it led to increased competition among iron ore producers.

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