THE DECLINE OF THE UNITED STATES STEEL INDUSTRY: A STUDY OF MARKET ENTROPY

A Dissertation

Presented to

the Faculty of the Graduate School

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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by

David H. Ciscel

May 1971

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ABSTRACT

The American steel industry is a declining industry due to fundamental changes taking place in its environment. The industry will be unable to adapt to this new environment under its present goal structure. In recent years, steel firms have increased prices several times but profits and sales continue to fall. The decline of the American steel industry concerns the collapse of a market: a market once considered central to an industrial economy.

The purpose of the study is to illustrate that under present market conditions the United States steel industry is declining or stagnating. Growth and stability are unlikely prospects for this industry. The objective is to show that to maintain the private and public goals of the industry, great changes will have to be made in the means used to obtain these goals.

The scope of the study is to view the steel industry in its national and international context since the Second World War. During this period the matrix of the world steel organization has changed dramatically. The study is not strictly within the confines of the microeconomics of the firm. Instead, the analysis is made at a middle level of aggregation, treating the industry as a unit and its behavior as uniform. The study largely ignores the plight of any individual firm, focusing instead upon the impact of the changing demand for steel, domestically and internationally, on the entire industry.

The methodology involves developing a behavioral model of the steel industry. The model is a semi-open system allowing for the interchange of the system with its external environment.

The empirical part of the study centers on three aspects of the market for steel: (1) the characteristics of consumption, (2) world production levels, and (3) the availability of raw materials.

Consumption: There are changes in consumption worth noting. It is important to note that the composition of demand for steel from steel using industries has not grown as rapidly as has the growth of demand in the user industries.

The steel industry was found to be growing at a slower rate than the economy over the 1947-1963 period. Steel, as a resource in investment and durable goods, declined over the 1947-1963 period. Many of the industries steel has traditionally supplied had sluggish growth rates. Only a few of steel's buyers performed as well as the economy. Within its market steel performed less well than its buyers. The value of steel supplied to its users declined relative to the value of the production of its users. In a few cases the value of steel used fell

absolutely as the value of the production of the buyer expanded. Between 1947 and 1963, every new dollar of demand in the economy had an increasingly smaller impact on the steel industry. This trend is demonstrated through a comparative analysis of the United States Department of Commerce input-output studies for 1947, 1958, and 1963.

Production: While the technology of producing steel has had two major changes in recent years--the basic oxygen converter and the continuous casting process--and many minor changes, this is not the variable of primary interest. Of real importance has been the proliferation of information concerning the methodology of steel production to the various nations of the world.

Growth of international capacity and production has automatically eliminated the United States industry from its post-war role as the dominant organism for the service of world steel needs. Changes in international production are shown for the post-war period on a country to country basis.

The pattern of production has changed. The steel industry is going through an international product cycle as described and developed by Raymond Vernon and Charles Kindleberger. During this century steel has changed from a high-risk, quality differentiated product in need of a large market, to a low-risk standardized product with a world market that anyone can attempt to enter.

The shift in production and the process of the product cycle are illustrated through an analysis of steel consumption and steel production in the steel producing nations of the world. The changes in the United States steel import-export situation are examined as a function of the shift in international steel production and of the changes in the nature of the product.

Raw Materials: Input factors such as iron ore, coal, and oxygen have been until recent periods available in large quantities in the United States. In recent years many of our great ore fields have decreased in quality. In some measure this has depleted the industry's supply advantage. To measure this, domestic production, imports, and exports of iron ore are examined. A finding of the study was that since 1950 there has been a dramatic shift from the use of domestic ore to the use of imported ores. The growth of Canada, South America, and Africa as resource sites has increased the uncertainty of stable resource supplies.

In conclusion, the results of the investigation revealed that the three factors listed above have caused a basic change in the framework within which the industry must operate. This study challenges the assumptions of recent studies by Walter Adams and Joel B. Dirlam that attribute the decline of the industry either to technological backwardness or to the industry's oligopolistic market structure. Instead, this study demonstrated that the problems of the industry can be attributed to basic structural changes that conflict with historical behavior patterns.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

THE DECLINE OF THE UNITED STATES STEEL INDUSTRY: AN INTRODUCTION

The American steel industry is a declining industry due to fundamental changes taking place in its environment. The industry will be unable to adapt to this new environment under its present goal structure. In recent years, steel firms have increased prices several times but profits and sales continue to fall. The decline of the industry has deep roots. Domestically the market for steel has not grown. Internationally the growth of world steel capacity has exposed the inefficiency of the industry to damaging competition. The study of the decline of the American steel industry is about the collapse of a market: a market once considered central to an industrial economy.

Three primary explanations have been offered in defense of the industry's problems. First, the American industry is felt by many analysts to be technologically backward. To this end, analysts have noted Europe's, Canada's, and Japan's early adoption of the new basic oxygen conversion process for making steel. Arguments pro and con seem to have established the fact that foreign producers have indeed developed a head start over the United States in adopting these new methods. However, the foreign producers' small scale of plant in these new facilities does not explain the totality of the American industry's present malaise. Secondly, United States steel is high priced relative to foreign steel. The blame is usually placed on the oligopolistic structure and conduct of the American industry or alternatively on the alleged "dumping" practices of the foreign producers. However, the high price of American steel is most probably the effect rather than the cause of the industry's problems.

Lastly, the industry often blames its poor conditions on high labor costs relative to foreign producers. These costs place United States steel at a comparative disadvantage--unable to make an acceptable rate of return at a lower price due to the abnormally high labor costs. In general, most American industries face high labor costs; and, in practice, other industries seem to conquer this problem through the high productivity of American labor, capital, and technology.

Examination of the steel industry's problems brings one basic conceptual issue to the fore. The traditional theory of the firm is in many ways much too restrictive to allow for competent analysis of this industry. Not only does the industry not conduct itself in a fashion resembling the models of competition or monopoly, but the traditional motivational assumption--profit maximization--is a wholly mistaken identification of the goals of the steel industry.

I. PURPOSE AND SCOPE OF THE STUDY

The purpose of the study is to illustrate that under present market conditions the United States steel industry is declining or stagnating. Growth and stability are unlikely prospects for this industry. The objective is to show that to maintain the private and public goals of the industry, great changes will have to be made in the means used to obtain these goals.

The scope of the study is to view the steel industry in its national and international context since the Second World War. During this period the matrix of the world steel organization has changed dramatically. The study is not strictly within the confines of the microeconomics of the firm. Instead, the analysis in the following pages is made at a middle level of aggregation, treating the industry as a unit and its behavior as uniform. The study largely ignores the plight of any individual firm, focusing instead upon the impact of the changing demand for steel, domestically and internationally, on the entire industry.

As pointed out above, economic analysis is not often wholly adequate to the normative values in this industry. In large measure this may be because the economic models of market determination tend to be overly mechanistic. A mechanistic analogy is a closed system that is unmindful of technological and cultural change. While profits and prices may help illustrate the present dilemma in the steel industry, they are not the factors which have brought the present market problems to fruition.

In economics, the model building approach to analysis has provided a solid basis from which to evaluate information concerning the real world. In particular, the composition of the world market for steel is the set of data to be used. The study examines the changes in the flows of factors and products in the domestic and world steel economy since the Second World War. In the process the behavior and reaction of the American industry will be noted. The empirical part of the study centers on three aspects of the market for steel: (1) the characteristics of consumption, (2) world production levels, and (3) the availability of raw materials.

Consumption: There are changes in consumption worth noting. While total aggregate demand has grown at an acceptable rate, demand for United States steel has not shown appreciable increases in recent years. It is important to look at the composition of demand for steel to see if expansion of steel use in construction, containers, automobiles, railroads, and other major steel users has been as great as the growth in these user industries. The composition of raw materials used by the major steel buyers brings about information concerning the continuing importance of steel.

Production: While the technology of producing steel has had two major changes in recent years--the basic oxygen converter and the continuous casting process--and many minor changes, this is not the variable of primary interest. Of real importance has been the proliferation of information concerning the methodology of steel production to the various nations of the world.

In part, the United States is responsible for the mystique of steel. Since World War II, there has been a continuing period of rising expectations for economic development by the world community. The identification of "steel" with the concept of industrialization is very prevalent in the less developed world. The interest in steel as a basic industry for development has spurred both developed and less developed nations to improve the quality of information which explains and assists in the development of steel production in non-steel countries. Due to damage inflicted by World War II, even Japan and the European nations could be viewed temporarily as non-steel nations. Growth of international capacity and production has automatically eliminated the United States industry from its post-war role as the dominant organism for the service of world steel needs. Changes in international production are shown for the post-war period on a country to country basis.

The pattern of production is changing. The steel industry is going through an international product cycle as described and developed by Raymond Vernon and Charles Kindleberger.[1] During this century steel has changed from a high-risk, quality differentiated product in need of a large market, to a low-risk standardized product with a world market that anyone can attempt to enter. Thus something resembling competition is introduced into a highly cooperative and rationalized market. Low labor costs, government assistance, and standardization of product make other nations' steel comparable to American steel.

Raw materials: Input factors such as iron ore, coal, and oxygen have been until recent periods available in large quantities in the

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[1]Raymond Vernon, "International Investment and International Trade in the Product Cycle," Quarterly Journal of Economics, Vol. 80 (May, 1966), pp. 190-207; and Charles P. Kindleberger, International Economics (fourth edition; Homewood, Ill.: Richard D. Irwin, Inc., 1968), pp. 55-69.

United States. Augmenting the large market demand for United States steel, these supply factors have given the United States industry a great locational advantage. In recent years many of our great ore fields have decreased in average quality due to the intensive mining of the best fields over the last century. In some measure this has depleted the industry's supply advantage. To measure this, domestic production, imports, and exports of raw materials are examined. The origin of iron ore imports sheds light on the changing composition of the supply of raw materials.

The methodology involves developing a behavioral model of the steel industry. The model is a semi-open system allowing for the interchange of the system with its external environment. The system, however, is closed in the sense that it is assumed to operate as a unit with its own goals, information processing procedures and decision-making organization. Any subset of the system may be considered important only so far as it contributes to the organizational functions of the system. The external influences on the system essentially shape the environment in which it lives.

Thus the system under consideration is the United States steel industry. Internal considerations are the availability of resources, its market, its productive capacity and sales, and its technological ability. External influences on the industry are the demands made on the system by the other segments of the domestic economy, and challenges made by foreign steel and resource systems.

II. REVIEW OF CURRENT LITERATURE

In recent years there has been a considerable amount of literature in the journals concerned with the problems of the steel industry. It is appropriate to examine the approach used in these articles, and it is necessary to understand the context within which their conclusions are made. By and large, the recent articles published by both proponents and antagonists of the steel industry have used as their conceptual framework the market models of microeconomics. It is the author's position that this approach is unduly restrictive and leads to incorrect or incomplete analysis of the problem.

One of the major criticisms of the steel industry has been that due to market structure, it has ignored technological improvements that would lower costs. Adams and Dirlam have led this discussion by pointing out in the American Economic Review that increasing imports in the steel rod markets are primarily due to the United States industry's inefficient open hearth methods of production. They contend that with the rapid introduction of the basic oxygen process and continuous casting, the United States industry would be able to meet foreign competition.[2] However, as Table I-1 shows, there has been a rapid increase in the use of the basic oxygen furnace by the American industry since the early sixties. If these new processes have lowered costs, it

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[2] Walter Adams and Joel B. Dirlam, "Steel Imports and Vertical Oligopoly Power," American Economic Review, Vol. 54 (September, 1964), pp. 625-666.

TABLE I-1

RAW STEEL PRODUCTION BY TYPES OF FURNACES

(Percentage of Total Domestic Output)

	Open Hearth	Electric	Basic Oxygen	Bessemer
1956	89.3	7.5	0.4	2.8
1957	90.2	7.1	0.5	2.2
1958	89.0	7.8	1.6	1.6
1959	87.4	9.1	2.0	1.5
1960	87.0	8.4	3.4	1.2
1961	86.3	8.8	4.0	0.9
1962	84.4	9.2	5.6	0.8
1963	81.3	10.0	7.8	0.9
1964	77.2	10.0	12.1	0.7
1965	71.6	10.5	17.4	0.5
1966	63.4	11.1	25.3	0.2
1967	53.8	11.5	31.5	---
1968	50.1	12.8	37.1	---
1969	43.2	14.1	42.7	---

Source: Standard and Poor, "Steel-Coal: Basic Analysis," Industrial Surveys (New York: Standard and Poor Corp., August 2, 1968, and February 26, 1970).

has not been reflected in the market price of steel.

In the development of their argument, Adams and Dirlam point out some of the causes of the United States steel industry's present predicament, when related to the dramatic increase in steel imports. They list five causes of the American industry's malaise:

1. The reconstruction and development of the war-damaged steel industries in Europe and Japan.
2. The installation of ultra-modern capacity in new steel facilities outside the United States.
3. The substantial increase in world steel capacity.
4. The development of export oriented pricing policies by European and Japanese producers.
5. The retention of a utility-like administered price policy by domestic producers in the face of growing competitiveness in the world steel market.

Adams and Dirlam place a large share of the blame on the industry for not adopting a more competitive price policy, adding that the industry's claimed inability to lower prices is directly linked to the industry's gross under-utilization of capacity, to technological lag, and to faulty investment decisions.

Adams and Dirlam state:

> Ironically, much of the U. S. Industry's current investment in plant and equipment is calculated not to add to capacity, but to correct the embarrassing investment errors of the last decade.
>
> Clearly, no internal domestic forces have been sufficiently powerful to ameliorate the questionable performance of the U. S. Steel industry. . . . Repeatedly the industry has been urged to

> reduce prices in order to increase sales, recapture foreign business, stem the import tide, reduce the threat of competing materials, operate at higher levels of capacity, and thus cut unit costs. But the industry persisted in its belief that the demand for steel use was inelastic and behaved as if this inelasticity applied even in markets where steel was confronted by competition from substitutes and imports.[3]

However, central to Adams' and Dirlam's article is the thesis that the primary reason that there is poor performance in the market is the industry's structural characteristics. The firms that dominate the industry are vertically integrated. The rigid price system that prevails in the industry and the poor performance that results from high prices can be traced to this vertical integration. The authors state:

> It is our contention that a vertically integrated oligopoly must maintain its administered price structure with all the economic and political weapons at its disposal. It must defend _a'outrance_ the vertical succession of keystone prices on which the entire price system rests.[4]

Thus Adams and Dirlam single out the vertical oligopoly market structure as the cause for the industry's poor market performance. This is in contrast, they point out, to the recent literature--notably articles by Spengler, Adelman, and Bork, which contend that poor market performance is most noteworthy in industries of horizontal integration of market power.[5]

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[3] _Ibid._, pp. 627-628.

[4] _Ibid._, p. 628.

[5] M. A. Adelman, "Integration and Antitrust Policy," _Harvard Law Review_, Vol. 63 (November, 1949), pp. 27-77; R. Bork, "Vertical Integration and the Sherman Act; The Legal History of an Economic Misconception," _University of Chicago Law Review_, Vol. 22 (Autumn, 1954), pp. 157-201; and J. J. Spengler, "Vertical Integration and Antitrust Policy," _Journal of Political Economy_, Vol. 58 (August, 1958), pp. 347-352.

Spengler defends vertical integration in the following manner.

> . . . In an imperfectly competitive world vertical integration enables the higher-stage producer to evade 'monopolistic' surcharges imposed by suppliers in lower stages, thus putting him in a position where he finds it advantageous to ask lower prices than would be asked in the absence of vertical integration and in the presence of existing horizontal integration. It follows that vertical integration, if unaccompanied by competition-suppressing amounts of horizontal integration, and if conducive to cost and price reduction, should be looked upon with favor by a court interested in lower prices and a better allocation of resources.[6]

Spengler's statement is consistent with the traditional theory of the firm which usually assumes the vertical integration of a representative firm in an industry. Rather than striking at the applicability of the theory of the firm in an oligopolistic market situation, Adams and Dirlam merely strike out at the obvious inapplicability of Spengler's theory in this one situation. In fact, they hypothesize that the opposite of Spengler's contention is true. Adams and Dirlam contend that if the industry had been organized in a series of large horizontally integrated firms, market forces would have been able to correct the poor performance.

The revival of the argument concerning the relative merits of horizontal or vertical integration probably missed the point. The core of the United States economy, particularly in manufacturing, is controlled by large vertically and horizontally integrated, and conglomerately aggregated firms. The conduct and performance of these firms can probably be said to be as varied as the goods they produce.

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[6] Spengler, op. cit., p. 352.

Indeed, the replies that followed this article largely ignored this aspect of the structural problem for the non-issue that it is. Instead, the replies attempt to invalidate the actual findings of Adams and Dirlam. In a 1966 American Economic Review comment, Reuben E. Slesinger takes Adams and Dirlam to task for expecting the impossible from the steel industry.[7] Slesinger feels that the industry had to contend with a huge capital stock which was not easily convertible to new methods.

> . . . Most of the capital becomes sunken and fixed once it is brought into being. The best that can be done in connection with technological changes is to attempt to keep the existing plant from becoming uneconomical to operate by making steady improvements and modernizations as these become technologically and financially feasible. It is only in the construction of new facilities that a firm has the option of using existing technology or new methods, even if the latter were operationally suitable at the time.[8]

Slesinger essentially speaks to the problem of the interrelatedness of existing technology. In such cases, it is difficult to replace one segment of a system without disturbing the technical and institutional patterns of the entire system. In other statements Slesinger even contends that the most important technological breakthrough--the basic oxygen furnace--was not adaptable to the American industry's large scale of plant in its early years of development. ". . . /I/t is imperative to recognize that the introduction of new methods is not

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[7]Reuben E. Slesinger, "Steel Imports and Vertical Oligopoly Power: Comment," American Economic Review, Vol. 56 (March, 1966), pp. 152-155.

[8]Ibid., p. 152.

"dictated solely by the availability of a new process."[9]

G. A. Hone and D. S. Shoenbrod, in a similar comment article, concur with Slesinger's conclusions, but add another criticism of the position taken by Adams and Dirlam.[10] They state that:

> . . . the United States was not significantly slower than Europe and Japan in adopting this new equipment and in no case was the percentage of capacity in these new techniques high enough . . . to have an appreciable impact on relative costs.[11]

In reply to their critics, Adams and Dirlam state that the technological barriers to adoption of the new methods were largely mythical.[12] They state that as early as 1954 the basic oxygen furnace was efficient and large enough to be used in the American industry quite effectively. Indeed, Adams and Dirlam force the issue back to the original question, largely ignored by the article's critics, by once again commenting on the structural inefficiencies of steel's market structure.

> The most significant question, of course, is not how much the U. S. steel giants lagged technologically, but why, despite their immense superiority in financial and technical resources, they

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[9] *Ibid.*, p. 155.

[10] G. A. Hone and D. S. Shoenbrod, "Steel Imports and Vertical Oligopoly Power: Comment," *American Economic Review*, Vol. 56 (March, 1966), p. 159.

[11] *Ibid.*

[12] Walter Adams and Joel B. Dirlam, "Steel Imports and Vertical Oligopoly Power: Reply," *American Economic Review*, Vol. 56 (March, 1966), pp. 160-168.

> lagged _at all_--either in invention or innovation, and against far smaller rivals both here and abroad.
>
> . . . [T]echnological backwardness meant that the industry was imprisoned by its higher book costs associated with past investment, and hence unwilling to meet the import threat with aggressive price competition. It thus reinforced the insensitive price behavior that was an outgrowth of vertical integration.[13]

Adams and Dirlam do attempt to bring the analysis back to their basic hypothesis. However, the critics' characteristic of ignoring the basis for Adams and Dirlam's argument have implicitly alluded to the fact that it may not be an overly important factor in the present paralysis of the steel industry.

In Adams and Dirlam's second major article on the steel industry, "Big Steel, Invention, and Innovation," the authors attempt to test the Schumpeterian hypothesis.[14] They feel that most economists have come to accept the corporatist philosophy that large corporations with some degree of monopoly power tend to be in a better position to innovate than the firm required to stand in the stiff gale of competition. Galbraith reiterated this belief in the oft repeated anecdote:

> The foreign visitor, brought to the United States to study American production methods and associated marvels, visits the same firms as do attorneys of the Department of Justice in their search for monopoly.[15]

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[13] _Ibid._, pp. 164, 168.

[14] Walter Adams and Joel B. Dirlam, "Big Steel, Invention, and Innovation," _Quarterly Journal of Economics_, Vol. 80 (May, 1966), pp. 167-189.

[15] J. K. Galbraith, _American Capitalism: The Concept of Countervailing Power_ (revised edition; Boston: Houghton Mifflin, 1956), p. 91.

Adams and Dirlam decided to test the Schumpeterian hypothesis by examining one aspect of the steel industry: the development of the oxygen steelmaking process. The authors used a historical two-pronged approach. First, they studied the history of the invention of the furnace in the steel industry. They contended that the basic idea of the oxygen converter was developed by Sir Henry Bessemer as early as 1856. However, two problems prevented its further development. Cheap production of oxygen was not possible, and attempts to use oxygen caused rapid deterioration of the converter.

The successful mass production of oxygen, however, was accomplished by Germans in 1929. The second problem was also solved by the Europeans in the 1940's. Rather than injecting the oxygen from the sides or bottom of the converter, oxygen is blown into the molten iron from the top where the reaction will not damage the walls of the converter. In summary, Adams and Dirlam state:

> It is noteworthy that the three major revolutions in steelmaking--the Bessemer, Siemens-Martin (open hearth), and basic oxygen processes--were not the products of American inventive genius nor the output of giant corporate research laboratories. The oxygen process was developed in continental Europe and perfected by the employees of a nationalized enterprise, in a war-ravaged country, with a total steel ingot capacity of about 1 million tons--by a firm that was less than one-third the size of a single plant of the United States Steel Corporation.[16]

The authors then turn to the question of the history of innovation in the oxygen steelmaking process. The history of early

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[16] Adams and Dirlam, "Big Steel, Invention, and Innovation," op. cit., p. 174.

innovation is replete with small foreign and domestic companies. In 1952 a small nationalized Austrian steel company (VOEST) installed the first oxygen process. In North America, a Canadian company (DOFASCO) and McLouth Steel installed the process in 1954. The major integrated companies did not start until 1957 when Jones and Laughlin entered, followed by United States Steel and Bethlehem in 1964 and Republic in 1965.

Adams and Dirlam then provide evidence accumulated from several industry sources that the capital costs for installation of the basic oxygen process ran considerably less than the open hearth process even after consideration was given to installation of oxygen production facilities for the new process.

Adams and Dirlam conclude the article by considering two topics. First, they look to the problem of low rates of return in the industry and the feeling that this impedes the march toward expansion and innovation. The authors argue that the industry's present series of price increases are merely an attempt to compensate for the complete lack of progressiveness during the decade of the fifties. Second, in an attempt to forestall any criticism on economics of replacement, the authors demonstrate that the industry's continuing addition of open hearth facilities during the fifties was without any justification, and that from the economics of replacement perspective much of the open hearth capacity should have been scrapped.

In conclusion, the authors feel that the universality of Schumpeter's hypothesis is in grave doubt and in particular has been refuted by the United States steel industry's hesitation in considering and adopting the major technological breakthrough in steel this century.

> In sum, given the steel industry's record of innovation with respect to oxygen steelmaking, it seems reasonable to suggest that Big Steel is neither big because it is progressive nor progressive because it is big.[17]

In 1967 Alan K. McAdams replied to the information presented in the article reviewed above.[18] His criticism is multi-directional. He states that in fact, the United States industry did not lag behind the rest of the world in oxygen application. Until 1958 the United States was the largest oxygen steel producing nation, when it lost its lead for several years to the Japanese industry.

While contending that the industry did not lag, McAdams offers several reasons for the industry's slow acceptance of this new process. First, in the period 1953-1960 when the new oxygen process was first available, the United States industry was in the post-Korean War doldrums. Second, McAdams offers the testimony of Francis A. Muller, Economic Affairs Officer of the United Nations Economic Commission. In a January, 1967, letter Muller states:

> It is quite natural that in the United States the main innovation effect is made toward improving raw material and energy savings since U. S. labor costs are so high.
>
> It is incorrect for the evaluation of the research and development effort of 'Big Steel' to pick out one single process development and to analyze the comparative results. The steel

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[17] _Ibid_., p. 184.

[18] Alan K. McAdams, "Big Steel, Invention, and Innovation: Reconsidered," _Quarterly Journal of Economics_, Vol. 81 (August, 1967), pp. 457-474.

industry is a complex industry with a very broad field for research and development.[19]

Thirdly, McAdams feels that Adams and Dirlam lack a comprehension of the technological interrelatedness of the numerous steps in the steelmaking process.

> Adams and Dirlam oversimplify the investment decision on at least two counts: first, they focus on a single step in the integrated production chain, steel furnaces alone. In doing so they assume away many of the problems of technological interrelatedness suggested above. Second, they fail to note that the manager may be faced with a series of mutually exclusive opportunities for improving his plant, all of which provide his firm with positive present value.[20]

At this point, McAdams seems to strike at the heart of Adams and Dirlam's article. Indeed, the oxygen process is somewhat blown out of proportion by their article. The steel industry is very complex from both a technological and managerial point of view. McAdams summarized by pointing out that those foreign firms which were the inventors and innovators in this particular process, while small relative to the mammoth American firms, retain quasi-monopoly positions in their own markets, often with government assistance. As such, solutions to problems in the American industry must be sought in other characteristics of the American industry rather than in the obvious domination of the market by a few firms.

In summation, McAdams states:

> Had Schumpeter stated the hypothesis: 'The three largest firms in an oligopoly industry will be the technological innovators in

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[19] *Ibid.*, p. 464.

[20] *Ibid.*, p. 467.

> 'that industry,' this hypcthesis would have been refuted by Adams and Dirlam's presentation in the case of the United States. But this was not Schumpeter's statement.[21]

In the rejoinder to McAdams' article, Adams and Dirlam quickly point out that their contention that the United States steel giants lagged with regard to invention was not even challenged by McAdams.[22] Further, Adams and Dirlam feel that there was, indeed, a definite lag in innovation even though the United States had the greatest oxygen converter capacity until 1958. They contend that relative to the rest of the world's productive capacity, the United States percentage of this new method was small. Adams and Dirlam still seek the answer to the question of:

> . . . why the United States industry (1) spends only 0.7 per cent of its sales dollar on any type of research and development and (2) failed to adopt a revolutionary new process which had been developed by others and at no cost to itself.[23]

To the issue of technological interrelatedness, Adams and Dirlam feel that there is no basis in fact for this type of problem. The authors maintain their original contention.

> Indeed, so far as the performance of the American steel industry is concerned, we implied that the contrary might be true: that more competition, rather than more concentration, is conclusive to innovational effort, and that such competition would tend to make

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[21] *Ibid.*, p. 474.

[22] Walter Adams and Joel B. Dirlam, "Big Steel, Invention, and Innovation: Rejoinder," *Quarterly Journal of Economics*, Vol. 81 (August, 1967), pp. 475-482.

[23] *Ibid.*, p. 479.

the adoption of new methods (and products) mandatory.[24]

Adams and Dirlam, in their two articles, present an excellent critique of the steel industry. They have isolated some of the dramatic effects of a declining industry. Profits stagnate, price policies become rigid even in the face of a large external attack, and the output is shrinking from the loss of an entire market (foreign) and penetration of another (through imports and substitute products in the domestic markets). They have concluded that the cause of the poor performance in the steel industry is its structure: a concentrated vertical oligopoly of Schumpeterian dimensions. The conduct arising from this structure, Adams and Dirlam hypothesize, is sluggish and unprogressive. The industry neither invents nor innovates, but is even unable to adopt proper market strategies to combat the penetration of their traditional markets.

The case is somewhat overstated. By and large the competition the industry faces from progressive foreign producers is not based on their structural organization. Most of these foreign producers operate and grow in strict oligopoly or monopoly markets. In fact, state control or manipulation of foreign producers is more often the case than not. The United States industry operates in a relatively free market, though certainly not a competitive one. Indeed, the lack of governmental protection is allowing the competition in the international

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[24] Ibid.

market to significantly affect the conduct of the domestic industry by revealing the industry's poor performance.

McAdams, while approaching the position of being almost a complete apologist for the ills of the industry, is correct when he speaks to the interrelatedness of technological and organizational structures of the industry. While not stating it explicitly, he seems to allude to the problem of history in any social or economic organization. An institution's background and development often tend to define the limits of freedom and scope of action, just as a picture frame limits the comprehension of action portrayed within it.

The question of market structure and the resulting market performance is quite crucial to Adams and Dirlam's argument. However, the validity or invalidity of the Schumpeterian hypothesis is one that is almost impossible to prove. It has been pointed out that much of the United States manufacturing capacity is centered in firms that closely resemble the steel industry in economic structure. Foreign innovators (Japanese steel, for example) are also highly concentrated and to a large degree government directed and protected. One study of some importance on industry structure and innovation was conducted by Edwin Mansfield.[25]

On a prima facie basis, Edwin Mansfield's work would tend to corroborate Adams and Dirlam's findings. Mansfield attempts to link

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[25] Edwin Mansfield, Industrial Research and Technological Innovation (New York: W. W. Norton and Company, Inc., 1968).

research and development expenditures with invention and innovation in several industries. Mansfield admits that many of the measurements were extremely difficult to quantify, but with the study's many limitations in mind, he has added an important contribution to the theory of the economics of technology. In particular, he attempts to test the Schumpeterian hypothesis in sections of his work. Mansfield looks at innovations in several industries over the period 1919 to 1958. His conclusions are particularly interesting, for the very cautious manner in which they are stated.

> First . . . in petroleum refining, bituminous coal, and railroads, the largest four firms accounted for a larger share of the innovations than they did of the market. But in steel they accounted for less.
>
> Second, the largest four firms seemed to account for a relatively large share of the innovating in cases in which (1) the investment required to innovate was large relative to the size of the potential users, (2) the minimum size of firm required to use the innovations profitably was relatively large, and (3) the average size of the largest four firms was much greater than the average size of all potential users of the innovation.
>
> Third . . . in the steel industry, they (the largest four firms) carried out no more than considerably smaller firms.
>
> Fourth, there is evidence that the smallest steel, oil and coal firms did less innovating--relative to large and medium-sized firms--in recent years than in the period before World War II. In steel this may be due to an increase in the average investment required to innovate. . . .[26]

Thus, Mansfield's study might seem to confirm Adams and Dirlam's hypothesis were it not for several other considerations. First, Mansfield affirms McAdams' complaint that to take the very largest

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[26] Ibid., pp. 107-108.

firms in a totally oligopolistic industry and compare them to relatively smaller, but absolutely large firms, may not be a real test of Schumpeter's contention. Second, there is real indication from Mansfield's study that the time lag in the innovation of the oxygen process on which Adams and Dirlam base their hypothesis is indeed no longer than the average lag for most American industries. Third, the importance of research and development funds to invention and innovation in a modern world is great. Mansfield's study indicates that the various R and D funding agencies may, in fact, be neglecting the iron and steel industry and thus causing the non-progressive characteristics of the steel industry. In 1964, the steel industry spent $113 million on research and development, only seven per cent of which was for basic research. However, the important point is that while the government financed 90 per cent of the $5097 million R and D budget in the aircraft industry, 60 per cent of the $2635 million budget in the electrical equipment industry and 40 per cent of the $483 million in the instruments industry, it financed less than two per cent of the R and D budget of the steel industry.[27]

In the last formal reply to Adams and Dirlam, Gerhard Rosegger attempts to demonstrate that the United States steel industry neither led nor lagged in the development of the basic oxygen converter.[28] He

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[27] Ibid., pp. 12-14.

[28] Gerhard Rosegger, "Steel Imports and Vertical Oligopoly Power: Comment," American Economic Review, Vol. 57 (September, 1967), pp. 913-917.

points out that Western Europe, Japan, and the United States installed approximately the same capacity of oxygen converters in the 1957-1965 era. While the Japanese percentage of total capacity of the new method was substantially greater than Europe's or the United States', this can probably be attributed to the very rapid expansion of the Japanese steel industry in the post-war period. The United States had no such similar motivation for building new facilities. In summation, Rosegger states:

> If one wishes to argue that a slow rate of technological progress had contributed to the competitive difficulties of the U. S. industry, one has to do so on some other basis than the history of the L-D process.[29]

In short, Rosegger seems to back Edwin Mansfield's finding that--in a non-compulsory situation--the lag between invention and innovation normally takes a decade or more, irrespective of the economic and secondary technological considerations. Thus, the United States industry's "wait and see" attitude of the 1954-1964 decade may have been merely a "normal" attribute of the innovative process.

Adams and Dirlam reply by stating that no matter how the figures are juggled, the result is still essentially the same.[30] In order to maintain the strict and stagnant powers of a vertical oligopoly, the United States industry did not respond to the competitive challenge. The industry, as the world's largest, denies the universality of the

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[29] Ibid., p. 917.

[30] Walter Adams and Joel B. Dirlam, "Steel Imports and Vertical Oligopoly Power: Reply," American Economic Review, Vol. 57 (September, 1967), pp. 917-918.

Schumpeterian hypothesis on a global scale. In summation, Adams and Dirlam state:

> That the U. S. steel giants lagged in innovation behind their smaller rivals at home and their Lilliputian competitors abroad is an indisputable fact. The explanation for this lag may be debated ad infinitum--unless, of course, one is prepared to accept our quite modest hypothesis that America's steel oligopoligists are slothful innovators.[31]

In contrast to the articles of Adams and Dirlam, G. S. Maddla and Peter T. Knight present a case for inclusion of the United States steel industry in a group of leaders of the adoption of the oxygen steelmaking process.[32] The authors are particularly concerned with the process whereby technological inventions developed in the advanced countries come to be adopted by underdeveloped countries. However, in the development of their article, the authors devote considerable time to the total economic advantages of the L-D (basic oxygen) process. From their investigation of data from the European Economic Commission and Economic Commission for Latin America, they come to the lengthy conclusion concerning this new process:

> 1. Over a very wide range of output the L-D process has lower total production costs than its principal competitors, the electric furnace and the open hearth. Thus, differential economies of scale cannot be considered a factor in the choice among different processes.
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> 2. Differences in the relative prices of capital and labour cannot be invoked as criteria for choosing between these three

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[31] Ibid., p. 918.

[32] G. S. Maddla and Peter T. Knight, "International Diffusion of Technical Change--A Case Study of the Oxygen Steel Making Process," Economic Journal, Vol. 77 (1967), pp. 531-558.

techniques, since the L-D process has the lowest capital-output ratio and the lowest labour-output ratio, and is thus on these grounds clearly superior to its competitors.

3. Two input prices, however, could conceivably affect the choice of technique between L-D and electric furnaces: the price of steel scrap and the price of electricity. The lower are either or both of these prices, the more favorable to the electric furnace, since the scrap-to-charge ratio approaches 100% for electric furnaces versus 30% in current practice for the L-D converter, and the electric furnace alone consumes significant amounts of electric energy. . . .

4. When the various elements of process 'flexibility' are considered the L-D process as it is today must be considered substantially inferior to the electric furnace and approximately equal to the open hearth, though this latter proposition is subject to some controversy.[33]

Maddla and Knight place the steel producing countries in five categories from "leaders" to "laggards" and "non-adapters." While the United States, Japan, the United Kingdom, Canada, and several others are classified as leaders, many other important steel producers such as Belgium, France, Luxembourg, and the U.S.S.R. are considered to have been slow to recognize the benefits of the oxygen furnace, and most of the underdeveloped world and Eastern Europe have given very little consideration to the adoption of the new furnace. In particular, the United States is found to be fairly progressive if one takes into consideration the market in which that industry operates. Maddla and Knight state:

For a country which has had a relatively small increase in steel output since 1956 (1964 was the first year since 1956 in which

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[33] Ibid., pp. 544-545.

production exceeded the 1956 figure), the record of the United States is not easily condemned.[34]

While condoning and even praising some of the actions of the United States steel industry, Maddla and Knight do not condone some of the investment actions of American and European steel producers in the late fifties and early sixties. They feel that on cost considerations, alone, only oxygen converters should have been built as either replacement or new capacity in the era after 1956. In some special cases, where the price of electricity or scrap was extremely low, there may have been some preference for an electric furnace. In any case, the continuing investment in open hearth facilities after 1956 was unjustified economically. Maddla, from his research, feels that different types of ores, product or scrap flexibility, or the availability of capital or skilled labor should have had no influence on abandonment of the open hearth method of production. In fact, he attributes the slow adoption of the oxygen converter largely to three factors: (1) differences in the rate of growth of steel production and age distribution of capital stock in different countries, (2) rigidities and lags in the planning process, and (3) ineffective planning.[35] In effect, Maddla and Knight seem to raise the problems of technological interrelatedness and institutional lag in the various steel economies. Indeed, while the authors tend to slide into the rhetoric of competition on occasion by

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[34]*Ibid.*, p. 549.

[35]*Ibid.*, pp. 551-556.

attributing some of the foot-dragging in the adoption of the new process to a lack of international competition, in general, they seem to realize that competition in the steel industry is largely an ethereal notion.

The official rhetorical position of the American industry is somewhat different from that claimed by its major critics. In general, the industry tends to mirror the positions in the articles of Slesinger, McAdams, Hone, and Shoenbrod. In particular, the technological standing of the United States industry relative to the industries of other nations is strongly defended. Indeed, the best presentation of its case is the analysis in The Steel Import Problem. This American Iron and Steel Institute pamphlet attempts to explain the background of the most important manifestation--other than poor returns on investment--of steel's problem: the growing penetration of the United States steel market by foreign producers.

The essential contention of the steel industry is that the firms of the industry are the victims of unfair competition. Since 1958, the American industry's export surplus has taken such a disastrous turn that imports may shortly have successfully encroached on nearly a fifth of the domestic market. The industry rejects out-of-hand the inefficiency in technological planning and in structural organization criticisms used by economists such as Adams and Dirlam, to explain the industry's present predicament of low prices (relative to desired) and of unstable market situations. The industry summarizes its position with the following statement:

> The basic forces which have brought these developments about are (1) the availability of substantial unused steel producing capacity elsewhere in the world and the policies of certain foreign countries with respect to this capacity, (2) labor costs in other countries which are far less than those in the United States, (3) the resulting prices of some steel products in world markets at levels below the domestic prices of many producers, and (4) the measures taken by other governments to protect and strengthen their own steel industries and to encourage exports.[36]

The industry contends that there are two basic reasons for the loss of part of the domestic market to imports. First, labor costs are felt to be high relative to those of steel industries in other nations. The AISI offers evidence that the major European and Japanese steelmakers incur employment costs less than one-half of those of the American industry.[37] Implicit in the AISI argument is that the responsibility for the high labor costs can be attributed to the monopoly power of labor. The high wage structure is not balanced by an overwhelming advantage in productivity for the United States industry. Secondly, the domestic industry feels that foreign governments encourage their industries to invade new markets as often as possible. The Europeans and Japanese are therefore accused of "dumping" steel on the United States market merely to satisfy their governments.

Since steel technology has become international since the Second World War, new advances in production techniques are disseminated in a very short period of time. This, in turn, makes the industry feel that research and development alone will not solve the problem for the

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[36] American Iron and Steel Institute, The Steel Import Problem (New York: The American Iron and Steel Institute, 1968), p. 1.

[37] *Ibid.*, p. 41.

domestic firms. The AISI concludes:

> As a result, the American steel industry increasingly is faced with a lower range of prices from foreign competitors. These are possible principally because of lower wage levels abroad. For this reason, the products of the United States steel industry are at a serious disadvantage, not only in world markets, but also within the large market of the United States.[38]

Indeed, the AISI seems to be less than overjoyed that a growing portion of the world is attempting to break out of the vicious circle of underdevelopment by introducing steel as an important aspect of the process of industrialization. In this process of development, most nations tend to protect their "infant industries" while at the same time exhorting them to produce export surpluses to create favorable balances of international payments. Such behavior, in the face of vast American technical and managerial assistance in the past two decades, seems inexplicable to the American industry.[39]

The AISI seems to believe that free trade would improve the situation, but adds that the barriers to free trade seem to be overwhelming in today's world. Free trade, it contends, should bring about equilibrium in world wage costs through a flexible exchange rate as well as equilibrating the international steel price. Since governments of foreign nations tend to interfere, free trade as an arbiter is unable to do its job in an impersonal market. The industry notes that most of the world's expanding steel industries are to one degree or another

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[38] Ibid., p. 3.

[39] Ibid., pp. 10, 17.

encouraged, financed, and controlled as an important facet of the national government's overall planning policy. To these successful methods of foreign governments, one of the most centralized non-competitive industries replies:

> . . . /T/he adoption by our government of many of the policies condoned or encouraged by other governments--capital allocation, formation of cartels or government direction of investment, research and marketing decisions--would be repugnant to our basic economic philosophy.
>
> Most of those methods would be unsuitable to the continuation and future growth of America's competitive economic system.[40]

However, when consideration is given to the industry's other arguments, the credibility of its defense of competitive systems seems even more suspect. The AISI spends a great deal of effort demonstrating the necessity of a healthy steel industry to our national security. Indeed, the industry implies that a weak steel industry would in turn weaken the entire industrial structure of the United States economy, thus increasing the likelihood of aggressive military policies from unfriendly nations.

> Unless the rising trend of steel imports is soon corrected, there is unlikely to be enough continuing investment in additional steel producing equipment needed to prevent critical bottlenecks in the nation's industrial machine in time of war. Realization of this by unfriendly powers could seriously affect our international relations.[41]

Bared of the war rhetoric, the industry's argument is essentially for a policy of "national self-sufficiency," not free trade. Trade

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[40] Ibid., pp. 4, 29.

[41] Ibid., p. 50.

under this philosophy should exist only when it is not necessary. Added to this argument, the industry claims that some 80,000 skilled American workers were displaced by the volume of steel imports in 1967. If the industry is as weak as it indicates, it might be well to release the other skilled workers in this industry to more productive vocations unless a strong case could be made for the maintenance of self-sufficiency in steel production for national defense reasons.

The several articles surveyed present an adequate overview of the concern about the American steel industry. The United States steel industry did not invent nor innovate very rapidly in the one major improvement in steelmaking. However, introduction of the oxygen process has proceeded fairly rapidly in the late sixties, particularly when the modest extent of market growth is taken into consideration. This new capacity in the oxygen process and electric furnaces has not helped very much. Steel certainly has not improved its position. In fact, only the international steel cartel formed in 1968 which cut 1969 imports by 4 million tons has reduced the rate at which imports are taking over the domestic market.[42]

While the rate of introduction of the new method was slow, Mansfield's work seems to indicate that this is traditional in every industry--innovation takes time. While industry structure might be related to part of the problem, the claim that the problems are related

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[42]Standard and Poor, "Steel: Basic Analysis," Industrial Surveys (New York: Standard and Poor Corp., February 26, 1970).

to a lack of competitive structure and conduct is without empirical foundation. If necessity were strictly the mother of invention, Japan, Russia, and Western Europe should have adopted the oxygen converter much faster than Maddla and Knight indicate they did.

The American Iron and Steel Institute is correct in pointing out that labor costs are relatively high in the domestic steel industry, although Japanese and West European steel workers' wages have risen quite rapidly in recent years. However, the industry as a whole ignored the problem of stagnant steel needs at home, and the rebuilding of steel capacity in other nations during the 1950's.

The problem that these several writers on the steel problem have ignored is the dramatic shift in both domestic and world steel needs since World War II. The critics find fault with the various American steel firms for their failures. However, the failure was that of the entire industry, and one that could not be avoided. Recently, J. K. Galbraith recognized one of the central problems.

> The crude steel capacity of a country was once a rather good indication of its ability to build railroads and meet its other needs for steel. It now tells nothing of the ability to provide special steels for the skin of supersonic aircraft or for similar uses. Technology has made crude totals far less meaningful. One must now know the nature of the accommodation to the more refined, more specialized and constantly changing requirements for the metal.[43]

The changing requirements for steel have had two side effects. The United States economy is no longer a steel economy; that is, just

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[43] J. K. Galbraith, The New Industrial State (Boston: Houghton Mifflin, 1967), p. 244.

as agriculture became merely another part of the economic system in the late nineteenth century, the age of steel is now over. While the United States still maintains a marked superiority to the rest of the world in the production of specialty steels and steel-alloys, the simplicity of crude steel production and the increasingly wide distribution of average quality inputs make crude steel production in the United States an unnecessary burden. In general, the economy would probably find it advantageous to use its highly specialized labor and capital in more productive pursuits.

CHAPTER II

STEEL IN A BEHAVIORAL CONTEXT

None of the explanations concerning the ills of the steel industry is really comprehensive enough to be satisfying. The problems of the industry are too complex to be attributed to the slow adoption of one new technique (relative only to its availability) or to high labor costs.

The extent of competition in the steel industry should be only one aspect of the analysis of a segment of our economy which is responsible for supplying materials of prime importance to an industrial society. The argument presented by Adams and Dirlam aimed at developing a dichotomy between the Schumpeterian (oligopolistic) market structure and the competitive market structure. By implication the latter was preferred and, it was inferred, would have probably solved many of the problems of the steel industry. The studies were highly normative. The question was asked: which form of market structure gives the best market performance? Adams and Dirlam pointed out the obvious imperfections in the oligopolistic steel market and attributed these imperfections to the lack of competitive structure and conduct in the industry.

An argument of this type is misleading. It presupposes a normative criterion--competitive market performance--and attributes deviation from the criterion to a lack of a specific set of primary criteria--competitive structure and conduct. The argument becomes: if acceptable conduct and structure exist then acceptable performance exists: if non-acceptable performance exists, there is non-acceptable structure. The argument is proper but may just as validly be couched in terms of the Schumpeterian. That argument is that acceptable performance is the result of an acceptable form of oligopoly, hence poor performance can be attributed to a non-acceptable form of oligopoly.

The steel industry is not so simple. Poor performance does not lead to a simple deductive conclusion. Consequently it is appropriate to broaden the concept of the system under study.

I. A REVIEW OF THE HOLISTIC FRAMEWORK

In studying an economic situation, the social scientists should stand off and take account of several aspects of the situation. First, the economic phenomena should be separated--although not detached--from the social or political aspects of the situation. Secondly, those variables or aspects of the situation which are important should be measured and converted into analyzable data. This is basically a problem of identification. Thirdly, there is the representation problem. How can the economic system (or part of it) be described in an analytic form or by a mathematical model so that further investigation may take place?

This third step in the economic process is the one most usually overlooked. Fundamentally this is because the traditional models of economics are assumed in economic analysis. In recent years this has led to many analyses of various parts of the economy that do not correspond with reality. This is often explained in terms of the narrowness of the model, or the influence of exogenous variables, but very rarely is the blame placed on the complete inappropriateness of the model. Instead of approaching each situation with the representation problem, more often than not this aspect of analysis is assumed away to more easily facilitate the transition to the more exciting parts of economic analysis: those of prediction, control, and design.

A problem's frame of reference is extremely important in defining the problem. This is recognized by most researchers who develop theories or models to describe given situations or environments. However, often it is not explicitly understood or explained that a frame of reference will lead to only a certain number of conclusions. Indeed the frame of reference may predetermine the outcome. The process of proceeding from premise to conclusion is usually considered of utmost importance, but the process should not be allowed to swamp the fact that the premises have inevitably determined the type of path travelled.

This is particularly true in economics. There is almost a standard frame of reference established for empirical study in microeconomics. Often the resultant model is not considered useful for the description of the behavior and operation of industries under empirical study. In particular, industry analysts have adopted a Structure-Conduct-Performance approach in their studies since the traditional models lack direct applicability to a real industry situation, However, after data have been gathered and compartmentalized, evaluation of performance becomes nearly impossible without rating the findings with regard to the traditional framework. Various aspects of the industry (e.g., number of firms, amount of price competition, allocation of resources, advertising budgets, etc.) are evaluated with regard to the competitive market structure. By summing the results from the particular parts evaluated, an economist can imply that the industry may be "generally" or workably competitive and recommend policies for improvement in particular areas.

This may be a somewhat valid procedure if the premises of competitive and monopolistic models are valid criteria for the evaluation of industry performance. However, a corporative system does not operate in a fashion similar to competitive models. If an industry or industrial situation is organized in a corporatist manner, then it is invalid to explain and to make policy statements from a non-corporatist framework.

In most of the studies concerning the problems in the steel industry, the recommendations usually call for some method of increasing competition in the industry, or of compensating for the absence of it. For example, researchers often issue a call for competition by breaking up the largest steel companies into many smaller units, e.g., each plant facility would become an individual company. Similarly a proposed merger of two medium sized steel companies can be blocked with the argument that the resulting situation would lessen competition when in fact there was little rivalry and competition in the first place.

Drastic remedies usually are issued to solve the ills of the steel industry. However, the organizational structure of the steel industry is little different from that of most other leading industries in the United States. In fact steel might be said to be one of the leading developers of the large corporate form of organization. Why, for example, are the steel industry and certain other basic industries repeatedly singled out for government harassment and trustbusting? Similarly structured industries do not seem to have the economic or governmental problems of the steel industry.

If a new type of economic analysis is needed to understand a corporate economy, several steps are necessary. First, it must be demonstrated what are the inherent problems in the premises of a traditional economic model for the study of this industry. Second, a new framework for economic analysis must be presented.

Perfect competition is the most important market model of the firm. The competitive market has several advantages. It is completely impersonal. Two manufacturers of the same product would not feel antagonistic toward one another, since neither directly influences the other. Similarly, neither manufacturer can threaten or feel threatened by the other. The individual manufacturer does the best he can, and his success is measured by whether he manages to match or exceed the average market performance.

Richard H. Leftwich offers a succinct justification for using the competitive model while admitting that it does not realistically describe or predict any important segment of the United States economy.[1]

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[1] Richard H. Leftwich, The Price System and Resource Allocation (revised edition: New York: Holt, Rinehart and Winston, 1960), pp. 25-27.

> First . . . pure competition . . . furnishes us with a simple and logical starting point for economic analysis. Second, a large measure of competition does exist in the United States. . . . Third, the theory of pure competition provides a 'norm' . . . .[2]

The second point is later highly qualified, although Leftwich's further explanation reveals a great deal about the other justifications for accepting the concept of pure competition.

> With regard to the first answer, an analogy can be drawn with the study of mechanics. No one questions the procedure of starting a study of mechanics leaving friction out of consideration. Assuming away friction allows a clear statement of mechanical principles. Friction is then introduced and taken into account. Competitive economic theory occupies about the same role in economic analysis as do frictionless principles in the study of mechanics.
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> . . . /E/conomic models set up on the assumption of pure competition furnish us with a 'norm' or 'ideal' situation against which we can appraise the actual operation of the economic system. . . . /I/f pure competition could and did exist throughout the entire economy, we would secure the fullest measure of economic efficiency.[3]

Two things need to be emphasized. First, the competitive model claims to be the most general model. If this were so, the law of parsimony alone would command its respect. Second, the competitive model is the criterion for judgment. In an utopian sense it represents the ideal form. Since its primary use is as a yardstick, competition is from its inception a highly normative concept.

The economic theory of markets tends to be organized around two poles: competition and monopoly. Monopoly offers a contrast and standard for comparison. The interesting aspect of the monopoly model

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[2] *Ibid.*, pp. 25-26.

[3] *Ibid.*, p. 26.

is that the behavioral assumptions are the same as in competition, even though the different types of firms operate in completely dissimilar environments. If an entrepreneur will struggle to maximize profits under the restrictions of competition, then, it is felt, he will certainly maximize profits with the freedom of choice allowed in a monopoly. But, why should he? The classic monopoly model basically assumes that there is very little difference between the monopolistic firm and the competitive firm except for the number of competitors present in the market.

The greatest fault was not realizing in a theoretical sense that the mere size of the firm's assets, sales, or resource use changes its position relative to the rest of the system. The relatively large firm by necessity has an important influence in the social and political community. This in turn gives more muscle to the firm to manipulate its economic environment--usually toward more securely protecting its privileged status. Internally, the size of the firm may necessitate the relegation of the entrepreneur's duties to several individuals. It must then be determined whether organizations of men behave under the same system of desires and drives and make the same types of decisions as does one man. When both the external and internal environments change, it is difficult to operate under the assumption that no adaptive changes in behavior will take place.

Reference should be made to oligopolistic and other semi-monopolistic market structures. Pure competition is usually defined in terms of a free and impersonal market. For example, if farming approximates pure competition, then one farmer may be in competition with another, but he does not have to compete with the other farmer. Oligopoly and monopolistic competition are market systems in which the impersonalism has been eliminated. The resulting interorganizational relationship more closely resembles rivalry than competition. Once one firm is able to assert itself and rise above its anonymity, scrutiny of the firm's behavior becomes important to the successful operation of the other firms in the industry. Early oligopoly and duopoly theory recognized the interdependence of firms. However, all oligopoly models suffered from a lack of clarity as to the actual operation of this type of market. In fact, the result was that oligopoly models were only able to describe some one aspect of a non-competitive market. Fellner, in Competition Among the Few, attempted to overcome this shortcoming of oligopoly theory.[4] The result of his analysis is more important for what it does not contain than for what it does. For example, the final model is one of limited joint profit maximization for the several firms in an industry. Joint maximization infers that the firms recognize not only their interdependence but also their interrelatedness. However, Fellner's limitations on profit maximization are so great as to almost obscure the profit motive.

This leads to one of the major criticisms of oligopoly theory other than its obvious inelegance. Under competition, there is much

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[4]William Fellner, Competition Among the Few (reprint: New York: Augustus M. Kelley, 1960 /original, 1949/).

that can be said for the hypothesis that operation of the market is as much responsible for motivations as the motivations are responsible for the operation of the market. That is, the environment is both maintained and extended by present structure and past actions. When a competitive market is eliminated, reinforcement of traditional motivation will be somewhat eroded. Proponents of theories of oligopoly and monopolistic competition usually sidestep this issue by maintaining the condition of free entry in the long run. This threat, it is felt, will maintain the motivation of profit maximization and the productive efficiency available in the competitive situation. However, this is basically a misreading of the market situation. The threat is basically one of a new rival, rather than the threat of competition. It seems likely that the firm would react to the threat of a new rival much in the same manner that it would react to a serious threat from a present rival.

In the economic theory of the firm there are two conceptual problems. First, the concepts used to describe the environment are to a large degree outmoded. Developed under the influence of the natural law philosophers and the Darwinian scientific revolution, elementary economic theory has failed to adapt itself to the newer fields of model building. Second, the environment which we are studying has changed enormously. It seems strange that social scientists would use the same criteria of motivation, operation, and evaluation for a small unit agricultural-industrial economy of the early nineteenth century as they would for a corporatist industrial-service economy of the late twentieth century.

Most of the faults of the traditional theory of the firm are partially traceable to the concept underlying the theory: holistic mechanism. The clock, in many instances, provides the most perfect example of mechanistic adaptation to the social sciences. Natural laws of motion in human affairs had to be identified so that the gears of the clockwork of society could be assembled correctly. Thus the satisfaction maximizing consumer and the profit maximizing entrepreneur operated in an atmosphere of enlightened and perfect knowledge. Given these natural attributes of man, the necessary job is to construct the best (in terms of social welfare) mechanism (economy) possible.

In The Nerves of Government Karl Deutsch explains some of the basic implications of accepting a mechanistic model.

> Classic mechanism implied the notion of a whole that was completely equal to the sum of its parts, that could be run in reverse, and that would behave in exactly identical fashion no matter how often those parts were disassembled and put together again, and irrespective of the sequence in which the disassembling or reassembling would take place. It thus implied the notion that the parts were never significantly modified by each other nor by their own past, and that each part once placed into its appropriate position, with its appropriate momentum, would remain in place and continue to fulfill its completely and uniquely determined function. . . . As this model implied certain assumptions, so it excluded others. The notions of irreversible change, of growth, of evolution, of novelty, and of purpose all had no place in it.[5]

This model of an economic system has to a great extent offered a greater understanding of the functions of an economy. In some instances

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[5]Karl Deutsch, The Nerves of Government (New York: The Free Press, 1966), p. 27.

it has offered clearcut policy recommendations for alteration of real situations. However, as the real world has increased in complexity, economic theory based on classical mechanistic models becomes less adaptable to encompass the subtleties of the real world.

With these criticisms in mind, it is now imperative to examine the availability of more complex models for explanation of micro-economic behavior. Kenneth Boulding has offered a system of models which in effect establishes a hierarchy of model types.[6]

First, there is a descriptive or static structure. A framework is set up to understand the basic geography of a situation. There is little more than a description of the parts of the system, with no real explanation of the functional relationships between the parts. In a sense it is the first step in systematic inquiry. Isolation and organization of the relevant bits of information are necessary for any framework of analysis. Usually, economic studies based on any variety of historical determinism are characterized by this type of system. The general parameters of the system may be identified but there is a lack of understanding concerning the internal operation of the system. Change or stagnation will be apparent but systematic understanding of it is not obtainable.

The second level of systematic analysis is characterized by mechanisms. These are simple dynamic or semi-static systems constrained

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[6]Kenneth Boulding, "General Systems Theory--The Skeleton of Science," <u>General Systems</u>, Vol. 1 (1956), pp. 11-17.

by the determinism of mechanical analogies. Most mechanistic systems will evolve to stationary or static equilibriums. While most economic models tend to be mechanistic, this type of model has been adopted more for conceptual or mathematical simplicity than from necessity.

The third level is the cybernetic or feedback type system. Developed by Norbert Weiner primarily for military reasons, it incorporates the transmission of information internally as the primary advancement over the mechanistic models. Equilibrium obtains a new meaning in this type of system. Stable equilibrium is not predetermined, but is maintained through an elaborate information system. A situation of equilibrium is defined as a goal in this system rather than as an inevitability. The system estimates its position relative to the goal and makes adjustments to accomplish the goal. Equilibrium is obtained through successive approximations. Stability can be defined as the characteristic of a system that is able to reach the goal; instability as the inability to reach equilibrium. Also, goals or equilibrium states are not inherently designed into the system, as a feedback system is not dependent on the achievement of any one goal. Kenneth Boulding refers to this type of system as the "level of the thermostat." The system will move to maintain any given level of temperature (goal) through the method of successive approximation.

The fourth type of system can be referred to as the "open" or self-maintaining system. This type of system is able to make adjustments for changes in the external environment. In a rapidly changing and complex world it is increasingly appropriate that systems which are in effect merely subsets of greater systems be fashioned to adjust to changes in exogenous variables. These changes fundamentally alter the environment within which the sub-system operates, such that goals and information processing will have to be viewed in a new light. Closely related to the idea of self-maintenance is the idea of self-reproduction of the system. To stretch a point, research and development programs of modern industry seem to have been introduced to achieve this lifelike quality for modern industry. Kenneth Boulding adds:

> What is clear, however, is that by the time we have got two systems which both reproduce themselves and maintain themselves in the midst of a throughput of material and energy, we have something to which it would be hard to deny the title of 'life.'[7]

This hierarchy of systems places the social scientist in an unfortunate dilemma. He is studying the most complex system--that of a social organization--without the capacity to understand it in its totality. Inevitably a dichotomy is formed between the real world and the unreal suprastructure which the social scientist adopts for the basis of analysis.

Writing in 1956, Boulding comments:

> Economics, for instance, is still largely a 'mechanics of utility and self interest,' in Jevons' masterly phrase. Its theoretical and mathematical base is drawn largely from the level of simple equilibrium theory and dynamic mechanisms. It has hardly begun to use concepts such as information which are appropriate at level iii (feedback systems), and makes no use of higher level systems. Furthermore, with this crude apparatus it has achieved a modicum of success. . . . Nevertheless at some point progress in economics is going to depend on its ability to break out of these low-level

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[7] _Ibid._, p. 15.

> systems, useful as they are at first approximation, and utilize systems which are more directly appropriate to its universe. . . .[8]

Richard M. Cyert and James G. March have made one of the more recent contributions to the theory of the firm. In *A Behavioral Theory of the Firm*, they have developed a decision making model based on an information feedback system which can and does replace the marginalist approach to allocation of resources and production of commodities.[9] While the Cyert and March decision making model provides an improvement in the traditional theory of the firm, it seems to have two weak points. It emphasizes internal decision making to the exclusion of very important traditional functions of the economic firm--those of the efficient conversion of the factors of production into salable commodities.

Cyert and March fail to implement their methodology in the marketplace. Goods are offered and sold in the same mechanistic manner which has characterized microeconomics. However, the marketplace is characterized by the same processing of information that typifies the decision making process inside the firm. Firms and consumers resolve conflicts, avoid uncertainty, learn, and search for solutions in the exchange of goods. Firms and consumers have goals--even if they are the simplistic ones of the competitive models. However, in the cybernetic or "open" types of systems, goals are the end result of a learning process and are open to revision.

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[8] *Ibid.*, p. 17.

[9] Richard M. Cyert and James G. March, *A Behavioral Theory of the Firm* (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963).

In early mechanistic models the market process raised grave problems. Instantaneous solution of the market most often had to be assumed. That Walras' theory of tatonnement, his solution to the problem of determinacy in a general equilibrium situation, was discussed separately from the actual model was probably intentional. The mechanistic general equilibrium of Walras was not sufficient to explain exchange in the market.

G. B. Richardson in Information and Investment has taken the assumptions of the competitive model to task. In his analysis, if the information assumption of perfect knowledge were accepted in a competitive model, the system would still be indeterminate because the entrepreneur would still lack the necessary information to enter or leave a market. Richardson comments on the problem of obtaining a market equilibrium.

> Now it can be shown that if transactions do in fact take place at the provisional (non-equilibrium) prices, then this could not but affect the nature of the equilibrium reached, which would no longer be deducible from the original determinants; whether Walras was aware of this difficulty, it is not easy to say. In turning to the full equilibrium of production and exchange he suggests an arrangement which would be free from this objection. The contracts entered into during the time when the provisional prices are 'cries au hacard' to be imagined as nominal and capable of revision; only when prices proposed call forth equilibrium values of supply and demand are they to be carried out.
>
> . . . [This system] demands the existence of a very special kind of agency to operate the system of tatonnement such as is not normally postulated as part of the system of perfect competition.[10]

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[10]G. B. Richardson, Information and Investment (New York: Oxford University Press, 1960), pp. 12-13.

Richardson tries to demonstrate that the elimination of an adequate information processing system from an economic model will preclude its usefulness to describe the equilibrium market in the real world.

The analogical approach has probably been one of the most fruitful methods used to comprehend complex systems. The basic approach has been to liken the operation of a very complex system to a vastly simpler one. In return for the loss of structural reality, expositional and analytical clarity is increased.

It has been demonstrated that the traditional theory of the firm relies very heavily on a mechanistic analogy. However, this analogy has become increasingly inadequate to explain the complex actions of the modern marketplace.

In rejecting a mechanistic analogy, it is important that the analogical method is not also scrapped. Recognition of a resemblance between two otherwise unlike structures is probably one of the reasons economic theory has been so popular among the social sciences. The theory of the firm clearly explains the operation of one type of market and the firms that compose that market. The seemingly fatal drawback of analytical methods that rely too heavily on mathematical rigor or institutional historicism is that they do not offer a teleologically satisfying argument or the expositional simplicity to explain both the function of the parts of a system and the meaning of the system as a whole.

This has been the attraction of the traditional theory of the firm. The mechanistic model adhered to a deterministic explanation of the market system. While its inadequacy has been apparent for some time, its beauty has commanded its retention far beyond its usefulness.

In recent years a great deal of work has been done in model building and the analysis of general systems. One result of studying system types has been the establishment of a hierarchy of system types similar to Boulding's presented above. The end result of establishing a hierarchy of systems is the realization that, at present, man has neither the technical capability nor the artistic talent to fully understand the finely woven fabric of an entire social system. Indeed, the only justification for the division of individual disciplines in the social sciences is that the whole cannot be functionally understood. Man's activities are separated into individually identifiable though interrelated categories--not by choice--but by necessity. Alfred Marshall, in his definition of economics, recognizes this problem. He states:

> Political Economy or Economics is a study of mankind in the ordinary business of life; it examines that part of the individual and social action which is most closely connected with the attainment and with the use of the material requisites of well being. Thus it is on the one side a study of wealth, and on the other and more important side, a part of the study of man.[11]

It is necessary to adopt a method of investigation which will allow for the influence of numerous internal and external variables while maintaining the initial purpose of studying and explaining one

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[11] Alfred Marshall, Principles of Economics (ninth [variorum] edition: New York: The Macmillan Company, 1961), p. 1. This is basically a reprint of the eighth edition of 1920, and it was edited by C. W. Guillebaud.

small portion of the economic system. The behavioral method offers a clear expositional but comprehensive analogy of the type needed to study an entire industry.

II. THE BEHAVIORAL MODEL

The behavioral approach emphasizes the interrelatedness of the parts of a system and its whole. The structure of the system and its resulting conduct will be determined by the goals of the individual parts as they influence the total system. The oligopoly market is naturally suited to the behavioral analogy. The concept of interdependence of competing firms in a market marked by personal conflict (rivalry) is the distinguishing feature that sets the oligopoly market apart from the traditional competitive or purely monopolistic markets.

The study of oligopoly has been frustrated by two problems--both arising from the mechanistic determinateness of the competitive system. First, there seems to be no rational process of price and output determination for the individual firm. Second, rivalry in the market blurs the motivation for profit maximization. Indeed, most market models have tended toward pushing the oligopoly market toward monopoly by assuming some semi-conscious form of collusion or toward competition through the assumption of free entry of new rivals.

A new theory of the firm now seems to be emerging--one which is particularly applicable to the oligopoly market. In particular, organization or group theory, which while clearly uncontrollably heterogeneous in inspiration, seems to be coalescing into a body of theory, which while less elegant than economic theory, adequately explains the behavior of individuals in an organized system. Almarin Phillips summarizes the basis for new oligopoly theory.

> It is based in part on a willingness to drop the assumption of profit maximizing behavior. More important, it is based too on a growing recognition that firms in oligopolistic markets are members of a group (or interfirm organization) which has an identity apart from the individuals of which it is comprised.[12]

The elimination of the assumption of profit maximization is central to the adoption of a behavioral approach. Theoretically, there is no longer an *a priori* group mind--goals of the group are fashioned as the result of interaction of the members. Thus profit maximization is not eliminated due to a lack of rationality on the part of the group or due to the problem of uncertainty, but because there is no *a priori* knowledge of the goal structure of a group. Instead, one has to settle for a brief outline of the goal formation process. A behavioral model includes a two step process. First, the goals (multiplicity is not excluded) must be spelled out; and, second, operational decisions must be made for the achievement of satisfactory performance to these goals. In general, economic theory has ignored the first process--even to the point of substituting non-maximizing behavior on the same *a priori* basis that profit maximization was assumed--and concentrated solely on the operational decision of the allocation and distribution of resources to meet the goal structure assumption.

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[12] Almarin Phillips, "A Theory of Interfirm Organization," *Quarterly Journal of Economics*, Vol. 74 (November, 1960), p. 604.

From a practical viewpoint, the firm fails to profit maximize because the oligopoly market offers a choice of alternatives. The rise of interdependence also causes or allows for the rise of the influence of the members of the group over the restrictive power of the marketplace. Profit maximization is relegated to the position of a special case. Given a large enough sample of oligopoly markets, there is the distinct possibility that such a group motivation might be found; however, the probability of the above occurring, given the multitude of goals and resulting combinations, would seem low. In fact, most oligopoly studies would seem to confirm this. These studies seem to find a multitude of primary objectives of the firm. The argument usually revolves around the problem of "dominance." In order to maintain the primacy of the traditional goal, the obvious profit goal of most firms is given priority, an act of inductive procedure that is neither empirically verifiable nor theoretically honest.

The behavioral approach also recognizes that the member firms of an oligopolistic industry belong to an organized group. Due to their interdependence, the group identity automatically arises. This most often is manifested in conduct that looks as if there were prior agreement. In an anti-trust context, the development of the concept of "conscious parallelism" recognizes that there is really no need for overt collusion to take place in order to have uniform industry behavior.

The oligopoly is very similar to the small group. In every organization, there tend to be two interrelated and interdependent subsystems: the formal and the informal groups. The formal group in organization theory is concerned with organization chart, chain of command, and formal communication. There is a similar parallel in the market. Concern over the structural make-up of the industry, relative sizes, and forms of communication corresponds to the formal aspects of the organizational system. The informal group is the result of communication ties which are created as the result of extra interaction that occurs whenever members of the group work together. An informal group will arise in an oligopoly industry due to working in areas of common interest, e.g., producing and marketing similar goods or dealing with very similar labor force problems. Thus the existence of the formal group--an industry--will bring a working informal group into play also. The informal group is the result of community of interest, business friendships, and frequency of contact. These informal relations between parts of the group are not merely a matter of friendly association unrelated to total market conduct and performance. In numerous organization studies, the informal group has been shown to have a major role in determining the attitudes and behavior of workers. In fact, the most powerful controls over the individual are usually exerted by the informal structure of the group.[13] In an oligopolistic market, the behavior of the individual firm is controlled by the mores of the group.

Almarin Phillips has developed a sketch of the industry group using the concepts of small group theory. He attempts to codify the

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[13] George C. Homans, The Human Group (New York: Harcourt, Brace and World, 1950), p. 190.

types of activities, interactions, and sentiments which will occur within the group, in order to better bond together the informal alliance and allow more efficient achievement of the formal structure's goal system. Phillips suggests four generalizations concerning the structure and efficiency of interfirm organizations.

> The interfirm organization must become more formal, better planned, and better co-ordinated if the efficiency of simple oligopoly (small numbers) is to be maintained with a larger number of firms in the group.
>
> In general, the more asymmetrical the distribution of power, given the number of firms, the less formal need the interfirm organization be to achieve the efficiency of simple oligopoly.
>
> In general, as the value systems of the members of the group become more unlike, it becomes increasingly necessary to formalize the organization if the efficiency of simple oligopoly is to be effected.
>
> Again generalizing, the better organized and more efficient are the groups from which and to which sales are made, the more formal and the more centrally directed must an interfirm organization be to retain a given level of efficiency.[14]

These four assumptions or generalizations from small group theory set the conceptual framework for a behavioral analysis of an oligopolistic industry.[15] In general, the informal group will be viable and strong in situations where the firms are few in number or where

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[14]Phillips, op. cit., pp. 607-610.

[15]It should be noted that these generalizations are implicit in the recent writings of political economists. See, for example, J. K. Galbraith, American Capitalism: The Concept of Countervailing Power (revised edition: Boston: Houghton Mifflin, 1956); J. K. Galbraith, The New Industrial State (Boston: Houghton Mifflin, 1967); and Robert T. Averitt, The Dual Economy (New York: W. W. Norton & Co., Inc., 1968).

dominance is achieved by one firm. Increased numbers of firms within the group calls the enforcement of the group's value system into question and creates uncontrollable rivalry, but does not necessarily call traditional competitive market factors into play.

The attention should now be shifted from the forces that call an organization or group into existence, and its two sub-systems (the formal and informal groups) to the components of the organization and the forces they exert on its goals and behavior.

Organization theory sheds a good deal of light on the behavior of firms in an oligopoly. Indeed the organization decision process developed by Richard M. Cyert and James G. March is equally applicable to market organizations as it is to the intrafirm decision process.[16] Within the market the individual firm faces many of the same forces that one member of the organizational coalition finds within the firm. The firm is faced with a somewhat uncertain environment in a limited market for both resources and final demand. Rival firms will have different and sometimes inconsistent goals and objectives for the use of both resources and demand. That is, one firm may be quality brand oriented, another sales growth, another size, and another technologically oriented. However, the several firms in the marketplace must ensure

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[16]Cyert and March, op. cit., p. 26. The authors state that only individuals, not collectivities, have goals. Their model attempts to demonstrate how the operating behavior of the business firm can be explained in terms of the numerous intrafirm groups and each group's several members. Within the Cyert and March framework, this study is attempting to explain and study the behavior of a slightly more complex organization: the market.

that the group as a whole maintains some standards in order to establish stability in the marketplace. For example, oligopolies are most often considered guilty of following a system of administered prices. Actually, this is a case of minimal group activity. Viability or survival being a central concern of the firm, a constant flow of revenue from a stable price structure allows the individual firm to plan for the future and the industry organization to maintain a viable organization coalition. Even within the confines of the market, inducements to the firm must at least equal the firm's contribution in order to maintain the delicate balance of the industrial coalition. Administered prices, while central to industrial stability, are by no means the only or the dominant form of interfirm inducement.

The goals of the industrial coalition are developed in three ways, as stated succinctly by Cyert and March.

> 1. The bargaining process by which the composition and general terms of the coalition are fixed;
>
> 2. The internal organizational process of control by which objectives are stablized and elaborated;
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> 3. The process of adjustment to experience by which coalition agreements are altered in response to environmental changes.[17]

The coalition is formed through bargaining, not necessarily by overt collusive methods, as to each firm's role in the industry. The coalition will be stable as long as each firm's role and resultant payments or inducements remain adequate to the maintenance of the

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[17] _Ibid._, p. 29.

organization. Cyert and March introduce the concept of slack in the bargaining process. "Slack consists of payments to members of the coalition in excess of what is required to maintain the organization."[18] Slack occurs only in markets where economic inefficiency exists--that is, where the pressure of the market is not overbearing. Within the flexibility of the oligopoly, firms can, over time, allocate a different level of status to each firm. The role each firm acts out within this confine does not necessarily have to be consistent with other firms' roles, given that the firms find no real motivation to strictly exploit the entire available market. The multiplicity of goals at the level of the single firm and the desire to maintain the stability of the industrial coalition are the central forces for cooperative division of the marketplace. This leads to the principle of indeterminacy. The industrial coalition will maintain an indeterminate market structure: one which is necessary to maintain the viability of the industrial coalition.

The process of control is also governed by the principle of indeterminacy through excess payment to the coalition's members. The coalition has ways of molding the payment to motivate the member firms to remain in the industrial coalition. These are compulsion, financial payments, and identification.[19] The first two of these motivational

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[18]Ibid., p. 36.

[19]Galbraith, The New Industrial State, pp. 128-132; H. A. Simon, Administrative Behavior (second edition: New York: The Macmillan Company, 1957), p. 115; and J. G. March and H. A. Simon, Organizations (New York: Wiley Press, 1958), p. 65.

criteria are, in a sense, traditional. Compulsion has always been a great fear of oligopoly markets, while also probably the least effective. The latter part of the nineteenth century is filled with examples of the giants in an industry attempting through great financial and market power to bring other firms into line. Rockefeller's control of the oil industry and his attempts to control the industry through manipulation of oil transportation and refining is a classic example. However, the history of such behavior is interesting for its failure to create a long run monopoly market structure.

Cartels and other forms of overt collusion usually are based on some sort of financial side payments. Indeed the purpose of the monopoly model is often to illustrate the effects of collusion. Rather than compete, the oligopolists form a quasi-monopoly structure, exacting excess profits from the consumer--profits which are later divided up among the various producers in some "fair share" arrangement. This has been the classic fear of economics, since Adam Smith warned that the probable result of the meeting of several merchants of the same trade would be a conspiracy in trade. Fellner's Competition Among the Few developed a case where an oligopoly naturally attempts to maximize the joint profits of the several firms in the industry. However, this implies a likemindedness of the several firms in the industry that is difficult to comprehend. The interest in this type of behavior seems to be inversely related to its occurrence. Section 1 of the Sherman Act aims directly at eliminating this form of behavior. It seems unfortunate that on several cases the Act has been used not to stop conspirators from maximizing the profits of the industry but rather to stop an orderly survival of the industry. Almarin Phillips comments on the nature of the enforcements of this particular point of law.

> It is curious that Section 1 has been interpreted with so little regard for effects. Several of the more important precedent cases involved factual situations not radically different from those which have resulted in exemptions from antitrust laws. The Traffic Association cases, the Addyston case, Maple Flooring, Trenton Potteries, Appalachian Coals, and Socony-Vacuum--all presented depressed conditions and excess rivalry prior to the agreements which led to antitrust action.[20]

While Section 1 may have prevented several forms of restraint in trade where profit inflation seemed the goal, in fact the resort of an industry to collusion seems in many cases to be the result of depressed conditions, rather than brighter profit bargains. The plumbing fixtures case of 1968 once again points out that industry chaos motivated conspiracy in order to maintain minimum rather than maximum returns. The steel industry adds another example. Throughout its history, the United States steel industry has repeatedly been guilty of price rigidity through several forms of collusion. The result has not been increased joint profits, but rather a diminuation of the market power of Big Steel, the growth of new rivals (including the entrance of foreign competitors), and the introduction of substitute products in many of its markets. Still there is a tacit maintenance of fifty years of tradition of collusion.

The most telling reason for the continuing conscious parallelism

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[20]Almarin Phillips, "Policy Implications of the Theory of Interfirm Organization," <u>American Economic Review</u>, Vol. 51 (May, 1961), p. 250.

of oligopoly behavior is that financial payments are not the primary motivation but instead the several firms are inspired by corporate identification with the industry. In organization theory, this implies that an individual will, when associated with a group, decide that the group's goals are superior to his own and identify with the group. "Humans, in contrast to machines, evaluate their own positions in relation to the value of others and come to accept others' goals as their own."[21] The ability of a firm and its management to identify with the industry group is important from this viewpoint. It is a cluster of members all attempting to deal with similar problems.

The translation of the concept of identification from the individual to the group might seem to be an invalid form of aggregation. It is not. Politically it is quite evident that the power in our political parties originates in the organizations and machines that control the party apparatus at the metropolitan or county level. However, the local parties have a strong identification with state and national parties for the purpose of long run stability and goal formation. While never advocating the abolition of the independence of the local party organization, numerous Democratic leaders have been dismayed by the Southern Democrats' lack of identification with national goals. In the

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[21] March and Simon, op. cit., p. 65. In addition, Galbraith's concept of adaptation--the ability to influence the group's goal structure--is included in identification. Most of these motivating constructs seem to be traced back in origin to Abraham Maslow's hierarchy of needs. It is the terminology that is important, as the literal translation of Maslow's psychological concepts to organization theory and market theory is probably invalid.

past, the lack of success of third parties has been due to the inability of local groups to identify with a national system.[22]

Unlike the classical models of oligopoly, intragroup cohesion is actually maintained by identification of the member firms with the industrial coalition's goal structure. The importance of the influence of the industrial group on the performance of the individual firm should not be underestimated. The success of the short order chicken food industry and the electronics industry in recent years led one investor to comment that merely the name "Chickentronics,Inc." would insure the success of such a firm.[23]

The steel industry seems to behave in a manner that is wholly more rational if the process of identification is taken into consideration. The goals of the industry are cohesive and to a large degree the desires of the member firms are subordinated to those of the industry. Within the industry framework many very diverse companies exist. The market share or profits of a firm are unimportant within some relevant range defined by industry standards. Group identity is so strong that in times of adversity, collusive pricing becomes almost natural to maintain the viability of the industrial coalition. In the late 1950's, when the industry was under government criticism for its technological

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[22] Governor George Wallace, in the 1968 Presidential campaign, seemed to find his greatest difficulty in presenting a group image with which diverse regional parties could identify.

[23] Adam Smith (nom de plume), The Money Game (New York: Random House, 1967), p. 121.

backwardness and resulting obsolete excess capacity, the formal industry organization, the American Iron and Steel Institute, merely stopped reporting capacity information. The clamor over excess capacity slowly disappeared.

While the nature of the industrial coalition, its members' motivations, and the resultant industry goals have been formulated, a process of group goal development should be included. In this respect, the four relational concepts of organizations developed by Cyert and March are applicable and quite useful.[24] These represent the heart of the decision making process. Most complete organization theories incorporate a very similar process; however, the methods of Cyert and March in _A Behavioral Theory of the Firm_ represent by far the most concise formulation.

The four concepts are (1) quasi-resolution of conflict, (2) uncertainty avoidance, (3) problematic search, and (4) organizational learning. Quasi-resolution of conflict is necessary to the multiplicity of goals. Cyert and March state: "Organizational goals are a series of independent aspiration-level constraints imposed on the organization by members of the organizational coalition."[25] The goals of the industrial coalition may be non-essential, non-operational, and sporadically enforced. Indeed the principle of optimization (central to Fellner's joint profit maximization) is appropriately denied with the

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[24] Cyert and March, _op. cit._, pp. 116-127.

[25] _Ibid._, p. 117.

elimination of internal consistency. Goals are arrived at and treated in a sequential fashion, thus resolving conflict by separating decisions in time.[26]

Uncertainty avoidance can be divided into two components: structural and conduct oriented avoidance. Structural uncertainty avoidance is usually accomplished through attempts by the industry to eliminate the rigors of the market at as many stages of production as possible. On the supply side, vertical integration can completely eliminate the dependence on independent sources of supply. Through integration, both the supply price and the quantity delivered can be regulated to administrative procedure--a step which not only increases the stability of the firm's production procedure but also decreases rivalry within the industrial coalition. On the demand side, integration can also dissipate market pressures. Contracts with buyers can guarantee certain parts of demand into the future. Government assistance through guaranteed sales and, particularly in steel, restrictions on imports can aid in reducing uncertainty through "improvements" in the structure. Uncertainty can be minimized also by establishing common forms of conduct within the industrial coalition. Basically this is a system of avoidance of the future. Decisions of the members of the coalition reflect a short run orientation, basically showing a flagrant disregard for long run implications. "They (organizations) avoid the requirement that they anticipate future reactions of other

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[26] Ibid., p. 118.

"parts of their environment by arranging a negotiated environment."[27]

The third relational concept is problematic search. The industrial coalition will only evaluate its position in times of need. The framework of the coalition will be questioned only when there is obvious need for a decision. Thus, search is motivated. In the search for a solution to any problem within the coalition, a standard decision rule is used. If decisions can be divided into two categories, habitual and novel, the law of parsimony commands the use of the habitual decision rule unless it is found ineffective. Lastly, decisions are biased by the industry's history. Novelty becomes less characteristic in a long established stable industry because a historical bias for certain decision types has had ample time to incorporate itself.

The steel industry, faced with numerous challenges to preeminence in the American economy, is replete with examples of simple problematic search. Faced with complaints of its technological progressiveness in the early sixties, industry sources explained the inapplicability of the new technology and its great strides in adopting it relative to other nations. As competition from foreign steel producers gained entrance to the American market, the industry set two standard procedures into operation: increase import restrictions and form an international steel cartel.

The last relational concept is organizational learning. Learning is related to the historical process of goal formation. The goals which

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[27] Ibid., p. 119.

create stability both within the industrial coalition and from society at large are developed from the experience of the several firms in the marketplace. The coalition will focus its attention on those variables that seem to have been important through its period of existence. Therefore, learning is specialized--concerned basically with the critical issues of the past. Learning is also contiguous. If the coalition must consider the possibility of the occurrence of two events, recent experience will dominate the expectation of the outcome.[28]

The goal formation process is complete. There are two important characteristics which by the nature of the industrial coalition are integral parts of its existence and because of their importance to the system warrant emphasis. First, there is an imperative for stability. While organic in origin, the need for stable relationships by any system is a dominant theme throughout all mechanistic, organic, and behavioral models.

Second, the principle of indeterminacy of the oligopoly should be stressed. The industrial coalition is founded in conflict--conflict which is resolved only to the point that member firms feel no compulsion to violate the norms of the coalition. Slack leaves the market underdetermined. Prices, advertising, product differentiation, and market shares are only consistent enough that industry goals are not impaired.

Since the industrial coalition is a historical phenomenon, goals are also of a historical nature. It is not of great importance what

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[28] Ibid., p. 123.

market and social forces were at work to develop the original group structure of the coalition. Indeed, such a development would be mere historical speculation. However, examination of industry reveals several very specific private and public goals. Through the tool of organization theory, the process of reinforcement and revision of the goal structure continues as a rational development of industry's group behavior.

III. GOALS IN THE STEEL INDUSTRY

In this context the steel industry may be seen as an important service organism to the national economy. The industry is a supplier of both goods for capital formation and durable consumption items. In an industrial economy, steel's importance is central to its operation. An advanced economy is often called a "steel economy."

The framework for analysis can be seen in the flow chart in Figure II-1. The steel producers, who form a highly concentrated oligopolistic market, behave in large part as a unit. There are goals and general behavior patterns that can be attributed to the industry as a whole. The actions of the United States steel producers can be rationally explained as growing from their historical role in the economy and the particular role they fill in supplying the steel needs of the economy. Historically, the steel producers have been placed in the center of the process. As producers they depended on a plentiful supply of raw materials. In terms of availability, most major firms integrated backward into the factors so as to maintain easy

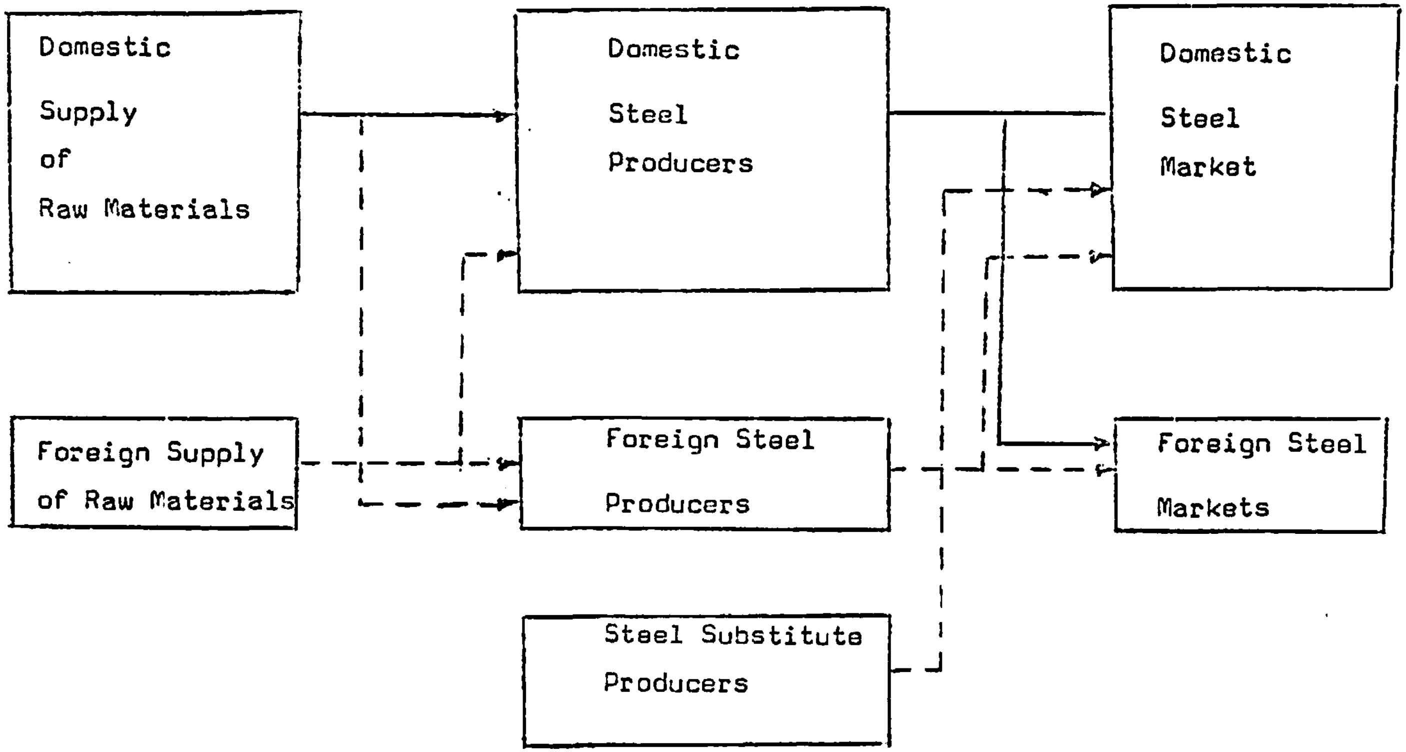

FIGURE II-1

BEHAVIORAL FLOW CHART OF THE STEEL MARKET

——— :Historical market patterns　　　　- - - - :Recent market developments accessibility. However, this can still be differentiated as two separate functions: supply and production. On the other side the producers serviced two markets: the domestic steel market, and the export market. The domestic market for steel is largely from fabricators who are responsible for filling demand for investment goods and consumer durables. The domestic steel market is largely a derived or indirect demand for steel products. The export market was maintained to fill excess foreign demand for high quality American products. It is within this framework that the steel industry has over several decades institutionalized its behavior patterns. Vertical integration to raw materials had stablized the input side of the market, so that the industry was primarily concerned with the maintenance of a high aggregate demand for investment and consumer durables.

However, since World War II, significant changes have taken place in the dynamic flow of the steel services sector of the economy. These changes have affected not only the domestic producers, but also their raw materials market, and the composition of domestic demand and the nature of the export market.

In general, the domestic steel market is no longer free of foreign influence. First, in raw materials, several things have happened. Large foreign ore fields have been discovered as domestic ore has become less plentiful and of lesser quality. Also foreign producers started buying various raw materials from the domestic market for their own production facilities.

Second, in production facilities, foreign producers added vast amounts to their productive capacity, thus reducing the American role in the total world steel community. To further reduce the domestic producers' importance, numerous steel substitutes have entered the market in the last two decades.

Third, while the level of aggregate demand has been largely stabilized since the Second World War, the domestic market has been reduced through the energetic entry of both foreign producers and steel substitute producers into the former closed market. The lucrative export market has now dried up as foreign nations begin to favor national steel production over imported steel.

The environment under which the domestic industry developed its behavioral patterns and the environment under which it must now operate are significantly different. Thus the process of adaptive decision making can be studied for the industry and a measure of effectiveness--relative to industry goals--can be made.

At the beginning of a study of an industry it is important to identify the performance norms of the industry. Independent of any one firm, how does the industry act and what type of goal structure does this show? The steel industry as a whole seems to have a two sided goal structure: a private set and a public set. The first side is that set of private goals. The private set has been the goals the industry has attempted to achieve. Stability in and control of the market for raw materials and for finished steel are the main criteria that seem to control the actions of the steelmakers. The demand for steel is basically derived from demand in other industries. Very little of the industry's production is for either final investment goods or final consumer products. Most production is either fabricated for consumption by other producers, or is processed into investment goods used in consumer production. A contraction in consumer demand will have a double effect on the steel industry. Not only will there be a fall in consumer demands, but the reversal of investors' future expectations for the need for steel as a capital good will combine with the former for a drastic cutback in steel production.

Historically, the reaction of the industry has been to form a large semi-collusive cartel that could control the market. On the input side the industry's firms consolidated "captive mines" into their corporate structure at a very early date. The vulgarities of a competitive market were eliminated and a highly rationalized input market was formed. On the output side, the process of consolidation was strong, but unfortunately centralization did not bring real market control. As early as the 1920 United States Steel case, it was decided by the courts that the concentration movement in steel was not merely a monopoly drive on the part of certain steel producers. Entry was limited but not closed, and information processes between firms allowed a cooperative environment in which the several firms in the industry were able to grow. Combination and vertical integration were able to offer the stabilities of controlled sources of supply, a rationalized process of production, financial slack on which to rest, and the possibility of greater political influence. As a result of steel's mammoth base, a great deal of slack could be taken in during times of economic recession, Due to high transportation costs, the pricing system could have been segmented and chaotic in a competitive market, but the various collusive pricing systems brought cooperative rationality to the market structure.

Throughout its history the industry has had one method or another to rig the prices and the distribution of steel. During the 1960's when steel imports began to affect the stability of the industry, the International Iron and Steel Institute arranged a voluntary steel import program among major steel producing nations. According to Standard and Poor, the restriction limited imports from the Common Market and Japan to 14 million tons of steel in 1969, 14.5 million tons in 1970, and 15 million tons in 1971.[29]

The stability of import controls cut foreign importance in United States steel production significantly and also allowed the industry the organizational freedom to enforce several price increases that it felt were necessary during this inflationary period.

The goal structure of the industry helps explain its strange behavior. In large part, steel behavior can be satisfactorily compared to that of a public utility. Lawrence B. Krause summarized the relationship between the industry's collusive behavior and its profit motivation.

> . . . /P/rices are set by the leader so as to yield a target rate of return on investment (stockholders' investment plus long-term debt). This return does not maximize profit but is one that is fair as determined by a process called 'public utility like thinking' and

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[29] Standard and Poor, "The Steel Industry," Industrial Surveys (New York: Standard and Poor Corp., February 26, 1970).

> and tempered by the need to face the competition of substitute metals, limit the pressure from congressional committees and avoid antitrust actions. Furthermore, the structure of the prices of individual steel products is influenced by the cost conditions peculiar to the product and the company's leadership position with respect to the rest of the industry. What results from this kind of price leadership is short-run stability in steel prices plus a few discrete shifts in the level of prices reflecting cumulated cost changes.[30]

The public set of goals for the steel industry revolves around the concepts of national self-sufficiency and national (military) security. The modern industrial state is often felt to be based on a "steel economy." The great nations of the world in this century can in some fashion be said to be built on steel. The degree of prominence accorded the steel industry in national power was ably discussed by John B. Parrish.[31] He relates the concept of industrialization to the growth of national steel industries. Parrish states: "Iron and steel output has proved to be, since the industrial revolution began, one of the best measures of the complex process referred to as 'industrialization.'"[32]

Parrish actually feels that much of a nation's power in the world is firmly based on its steelmaking capacity. The world balance of power seems to hang on a nation's ability to produce steel. "For both the

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[30] Lawrence B. Krause, "Import Discipline: The Case of the United States Steel Industry," The Journal of Industrial Economics, Vol. 7 (November, 1962), p. 39.

[31] John B. Parrish, "Iron and Steel in the Balance of World Power," The Journal of Political Economy, Vol. 64 (October, 1956), pp. 369-388.

[32] Ibid., p. 370, f. 6.

"United States and Russia the duopoly of power will become increasingly complicated as industrialization spreads steel capacity around the world."[33]

While the rhetoric Parrish uses may seem slightly exaggerated, his viewpoint seems to dominate the position most informed sources take concerning the importance of steel to a nation's industrial and military power. Olin T. Mouzon is typical in his evaluation of the industry.

> Steel is the basis of industrialization. Since steel in one form or another enters into every part of the economy, the steel industry has always been considered an important barometer of general business conditions. More fundamentally, however, the capacity to produce steel, sustained production, and the availability of raw materials are excellent measures of the productive capacity and strength of a country.
>
> Since steel is the basis of industrialization, its continued growth is essential if the United States is to attain its objective of an expanding economy.[34]

The public goal of the industry is centered around the idea that the nation has an obligation to maintain a vigorous and profitable steel facility. The American Iron and Steel Institute explains the public importance of steel.

> Its central role stems from the fact that the buildings, tools and equipment which represent the productive capital stock of a modern economy are dependent on steel even though, in most cases, it represents only a small portion of the cost of the article which contains it. Beyond that, it is an important material in consumer durables, housing and the means by which consumer services are provided. Although much military hardware today consists of materials other than steel, all of it includes some vital steel

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[33] Ibid., p. 382.

[34] Olin T. Mouzon, Resources and Industries of the United States (New York: Appleton-Century-Crofts, 1966), pp. 332, 380.

> components for which no substitutes are known. The kinds of steel needed for those uses are extremely varied and the demand for them is unpredictable.[35]

The private and public goals of the industry tend to mesh well in many situations. During the 1960's, the United States steel industry was criticized for its technological backwardness and its monopolistic pricing system. B. W. Lewis summarizes the industry's behavioral characteristics.

> And now, the cream of the jest: our own steel industry, seeking to build a public opinion favorable to an increase in steel prices, presents its case for a larger profit, not on classical market theory which its activities presumably exemplify, but on good solid nationalization theory--the industry needs more profit as a source of capital funds for needed expansion.[36]

In the next two chapters it will be demonstrated that the steel industry is going through an extended learning process. Due to some basic changes in the technical attributes of steel production, the goal structure of the industry is undergoing serious revision. Figure II-1, page 69, illustrates this dilemma. The industry had largely considered itself a closed system: supplying its own resources to a small set of integrated producers who then in turn supplied a growing domestic and export market. Today many of our raw materials are imported and some of the raw materials that the United States still retains are shipped to foreign producers. Domestic steel capacity has been matched in

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[35] American Iron and Steel Institute, The Steel Import Problem (New York: The American Iron and Steel Institute, 1967), p. ii.

[36] B. W. Lewis, "British Nationalization and American Private Enterprise: Some Parallels and Contrasts," American Economic Review, Vol. 55 (May, 1965), p. 57.

quality in many areas of the world, and these new foreign producers not only deliver steel to their own markets but have substantially penetrated our domestic market. The number and quality of steel substitutes has grown significantly. The domestic market for steel has declined relative to the rest of the economy.

These changes in the system in which steel operates can not be compensated for by merely changing the industry's price structure. Nor will mere import restrictions or an informal cartel help the process of adapting to steel's new environment.

CHAPTER III

THE IMPACT OF UNITED STATES INDUSTRY ON DOMESTIC STEEL PRODUCTION

The weak position of the steel industry in the United States economy can be partially illustrated in the comparison of the requirements tables of United States Department of Commerce Input-Output tables of the United States economy. Twenty-three industries that account for about 90 per cent of the domestic demand for steel are investigated.[1] The comparison will cover the change in the requirements coefficient (both direct and total) for the three input-output studies made by the United States Department of Commerce. The three studies are for the years 1947, 1958, and 1963--thus resulting in a 17 year time series. The break in the series of 1958 is of considerable importance.

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[1]Conceptually and statistically the three studies are almost entirely consistent with one another. Prices and industry classification also have been adjusted for consistency. The 1947 and 1958 input-output studies are in terms of 1958 prices. The 1963 study is in terms of 1963 current prices. This will result in some price level discrepancies, the correction of which would have induced more errors than the present method allows for. The primary classification difference is the lack of a dummy industry (82) from the 1947 study: an omission which has no effect on the analysis of this paper. Office of Business Economics of the United States Department of Commerce, The Input-Output Structure of the United States Economy: 1947 (Washington: Government Printing Office, 1970); National Economics Division of the Office of Business Economics of the United States Department of Commerce, "The Transactions Table of the 1958 Input-Output Study and Revised Direct and Total Requirements Data," Survey of Current Business, Vol. 45 (September, 1965), pp. 33-49; National Economics Division of the Office of Business Economics of the United States Department of Commerce, "Input-Output Structure of the U. S. Economy: 1963," Survey of Current Business, Vol. 49 (November, 1969), pp. 16-47.

It is from this year that most studies date the beginning of the decline of the industry. It was during this period that American steel's large export surplus began to turn into an import deficit. It was in this period that the basic oxygen converter began to gain popularity overseas. It was in the 1957-1958 period that the government became interested again in the industry's oligopolistic conduct, particularly its rigid price structure.

The 1947 base year is useful in that it portrays the type of production mix that still seems to dominate steel's psychological makeup today. In 1947 United States steel dominated both the international and the domestic markets. Internationally it was the only large scale efficient steel industry to survive the Second World War. Domestically, the United States was still a steel economy; i.e., the industry could rightfully claim that our industrial prosperity was largely built on steel.

The time series ends in 1963 during a period of rapid economic growth--a period when steel should have shown signs of recovery from the recession and political difficulties of the late fifties.

I. THE INPUT-OUTPUT TABLES

In the analysis of the industry between 1947 and 1963, this study uses the three tables of the input-output studies. These tables have been abridged in order to summarize the parts that deal with the steel market.[2] The tables are interindustry transactions, direct requirements, and total requirements of steel.

1. Interindustry Transactions Table (Table B-1, Appendix B). This table shows the dollar value of the transactions among the various industries. Each column shows the value of the steel industry's input of raw materials, and semi-finished products, for the column industry, and the total value of the output of the column industry.

2. Direct Requirements Table (Table B-2, Appendix B). This table relates each of the inputs of an industry to its total output. Each column shows the inputs that the industry named at the top of that column required from each of the industries named at the beginning of the rows to produce a dollar of output. For example, in 1947 to produce a dollar of output, the primary iron and steel industry (37) required 52 cents of its own production, 3 cents from the nonferrous metals industry (38), 5 cents from iron ores mining, etc. Thus, for the twenty-three industries studied here, there is a concern with the direct input per dollar of output required from the primary iron and steel industry over the 17 year time period.

3. Total Requirements Table (Table B-3, Appendix B). Each column of this table shows the output required both directly and

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[2] For a complete list of the industries examined in this study and the Standard Industrial Classifications, see Table A-1 in Appendix A.

indirectly from the industry named at the beginning of each row for each dollar of delivery to final demand by the industry named at the head of the column. In the example above the primary iron and steel industry required 3 cents of direct output from the nonferrous metals industry but a final demand of one dollar for steel would stimulate a total of 7 cents of production from nonferrous metals producers. The total requirements table shows the total impact of the twenty-three industries on the steel industry, per dollar of final demand for the years under investigation.

Of interest in these tables are the changes in the direct and total requirements coefficients for the twenty-three industries over the 17 year period. The change in either coefficient can be explained by two changes in the economy.

1. There may be sectoral shifts in demand. If the composition of final consumer, government, and investment demand changes in the economy, relative prices of different industries' factors will change, causing a shift in the composition of an industry's inputs per dollar of output or final demand.
2. Technological change, both progressive and regressive, in an industry will affect the attractiveness of the industry's substitutes, which will in turn bring changes in both the direct and total requirements coefficients as industries alter their factor mix in response to new relative prices.

No attempt will be made here to separate these two influences. In fact, in this study we are concerned only with the impact of these two factors over the 17 year period. The data allow for a two step process of analysis. First, for each industry that required large steel inputs, examination of its steel requirements between 1947 and 1958 will indicate if, in American steel's brighter days, there was an indication of problems ahead due to a change in each user's factor mix. Secondly, it is important to see if the 1947-58 trend continued to 1963 when the economy had moved into a period of accelerated growth. The overall economic growth rate in real gross national product (1958 dollars) increased from an annual average 2.1 per cent between 1955 and 1961 to 4.3 per cent between 1960 and 1964.[3]

The twenty-three industries selected for analysis were picked for the importance of steel in their factor mix (Table A-1, Appendix A). Each industry used in 1947 at least 5 cents of directly purchased steel for every dollar's worth of output. Industries that are either small steel users or use steel as only a small part of their set of inputs are excluded. The twenty-three industries composed 84 per cent of the value of the total intermediate output in 1947, 91 per cent in 1958, and 90 per cent in 1963.[4]

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[3]United States Bureau of the Census, <u>Statistical Abstract of the United States: 1966</u> (Washington: Government Printing Office, 1966), p. 320.

[4]Total intermediate output is the sum of the value of output of the steel industry that is sold to every industry in the United States economy. It excludes those few categories of final demand. In the steel industry the quantity of steel sold directly to final demand is extremely small.

In the period under study, the twenty-three industries actually became more important in terms of the percentage of total intermediate output purchased from the steel industry. This is due to the fact that many of the smaller buyers of steel tended to move into substitutes. While they purchased less than 5 cents of steel per dollar of output, industries such as coal mining, maintenance and repair construction, lumber and wood products, household furniture, petroleum refining, primary nonferrous metal manufacturing, transportation and warehousing, and electric, gas, water, and sanitary services all had significant decreases in the absolute quantity of steel used between 1947 and 1963. In many of the more dynamic industries of the American economy, steel tended to remain somewhat static as an input supplier.

Using the input-output study computation, the gross national product increased by slightly over 42 per cent between 1947 and 1958, and by 88 per cent between 1947 and 1963.[5] For each of the twenty-three industries it should be noted whether it grew as fast as the economy during the period under consideration. This will give a further indication if steel is engaged in supplying the progressive sectors of the economy regardless of the composition of these industries' inputs.

II. ANALYSIS OF THE INDUSTRIES

New construction (11) expenditures have a record of consistent growth during the 17 years under study. Total value of output increased

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[5]Table B-1, Appendix B.

by 77 per cent from 29,591 million dollars in 1947 to 52,416 million dollars in 1958. In the next five years new construction grew by another 13,103 million dollars--a 121 per cent increase over 1947. However, during this period steel supplied directly to new construction rose only by 39 per cent from 1,534 million dollars in 1947 to 2,125 million in 1963. Per dollar of output steel's contribution to new construction dropped significantly from over 5 cents to about 3 cents: an 18 per cent drop by 1958, and a 37 per cent drop by 1963. Total requirements of steel also reflect the shift out of steel in this industry. Per dollar of final demand the total (direct and indirect) steel requirement fell from 13 cents in 1947 to 11 cents in 1958 to 9 cents in 1963.

Military ordnance (13) excluding aircraft, has been one of the major growth industries in the post-World War II era. From 249 million dollars in 1947, the industry had grown to 4,669 million dollars in 1958, and to 6,302 million dollars in 1963, for a 2,431 per cent increase in value of product in 17 years. Even though steel used in ordnance increased from 23 million dollars in 1947 to 149 million in 1963, the growth of the industry far outstripped its need for steel. During the 17 year period, steel needed per dollar of output fell by 74 per cent from 9 cents to slightly over 2 cents. Total requirements reflect the same trend, although the rate at which the importance of steel was falling seems to decrease after 1958. In 1947 each dollar of final demand in ordnance required a total of 14 cents in steel. By 1958, this had fallen to 7 cents, but by 1963 the requirement had fallen only to

6.6 cents. Thus, during the beginning of steel's total market problems, the exit from steel use in ordnance had already been accomplished.

The furniture and fixtures industry (23), excluding household furniture, is one of the few sectors where steel improved its position. While the growth of the furniture industry had been respectable, 24 per cent from 1947 to 1958 and 60 per cent during the 17 year period, it was less than that of the economy taken as a whole. In 1947 the furniture industry spent 106 million dollars on steel from a total value of product of 1,205 million dollars. By 1963 this had increased to 181 million dollars of a total of 1,923 million dollars. This is equivalent to 8.8 cents in 1947, 9.3 cents in 1958, and 9.4 cents in 1963 per dollar of output: a 7 per cent increase. However, the total requirements data reflect how fragile the gain in this industry was. During this period, direct and indirect use of steel per dollar of demand rose slightly by .1 cent in the 1947-1958 period, then back down by .2 cent in the 1958-1963 period for an overall fall in steel needs from the furniture industry.

The steel industry (37) is a particularly interesting case of steel use. As other industries have shifted their factor mix to steel's detriment, the impact on steel's growth has been dramatic. There was a fall in production of 10 per cent between 1947 and 1958. In 1947-1963 the value of steel's product grew by only 14 per cent from 21,525 million dollars in 1947 to 24,618 million dollars in 1963. In this same period the industry became more conservative in the use of its own product. By 1963 a dollar of output required only 20 cents of steel, down 13 per cent from 23 cents in 1947. In 1947, a dollar of demand stimulated almost $1.32 in steel production. While there was only a slight decline in the 1947-1958 period, by 1963 only $1.29 was generated from a dollar of final demand for steel. This 2 per cent decline helped accentuate steel's troubles.

The metal containers industry (39) has been a problem area for the steel industry during the entire post-war era. Not only have aluminum cans penetrated the market, but substitutes such as glass, plastic, and paper for frozen foods have caused the industry to grow by only 62 per cent in the 17 year post-war period. This was a time when prepared foods grew at a very rapid rate. In direct requirements, the metal containers industry's use of steel fell from 52 cents per dollar of output in 1947 to 44 cents in 1958 and finally to 41 cents in 1963. The total steel requirements further dramatize steel's decline in this substitute conscious industry. Requirements of steel per dollar of delivery to final demand fell from 73 cents in 1947 to 54 cents in 1963: a 26 per cent drop in total steel needs over the 17 year period.

The heating, plumbing, and fabricated structural metal products industry (40) is essentially a conglomerate of construction supply firms. While the impact of the shift out of steel is not as dramatic as in new construction as a whole, this industry has also shown indications of using substitute raw materials. Each dollar of output required 26 cents of steel in 1947. This dropped to approximately 24 cents by 1958 and remained fairly constant through 1963. In terms of total steel requirements per dollar of final demand the trend was fairly similar.

In total requirements there was a 15 per cent drop in steel required. In terms of cents per dollar of final demand it went from 41 cents in 1947 to 36 cents in 1958 to 35 cents in 1963. Thus, while the steel industry supplied 2,154 million dollars worth of steel to this 8,996 million dollar industry in 1963, the trend was a relative decline in steel's importance.

The screw machine products, bolts, nuts, etc., and metal stampings industry (41) had a very poor performance over the 17 year period. From 1947 to 1958 the value of output fell from 3,881 to 3,714 million dollars. During the next five years there was some recovery as the industry output grew to 4,955 million dollars. Direct requirements of steel grew from slightly less than 21 cents to slightly over 21 cents per dollar of output in the 1947-1958 period. However, total requirements indicate that steel needs in this industry actually fell off by over 9 per cent between 1947 and 1963.

The other fabricated metal products industry (42) is merely an aggregation of several small industries that provide low volume intermediate and finished metal products. Over the time period the industry's growth rate was impressive. From 1947 to 1963 the industry had grown from a 4,718 million dollar to an 8,963 million dollar industry. Steel's contribution per dollar of output grew from 15 cents in 1947 to 17 cents in 1963: a net change of about 14 per cent. Total requirements of steel for this industry remained almost constant during the 17 year span. Total steel requirements had grown by 14 per cent from 26 cents in 1947 to 29 cents in 1958, but by 1963 the advances had been eliminated.

The engine and turbines industry (43) is particularly interesting. It had a modest growth of 44 per cent over the 1947-1963 period, resulting in an increase of value of output from 1,668 million dollars to 2,398 million dollars. However, direct steel transactions decreased from 239 million dollars in 1947 to 235 million dollars in 1963. This is an indication of the significant change in the factor mix that took place in this industry. Direct requirements of steel fell from over 14 cents of each dollar of output to less than 10 cents after 1958. Per dollar of delivery to final demand, the reduction in steel needs is even more dramatic. In 1947, 28 cents of steel was required. It has fallen 29 per cent to 20 cents in 1958 and it fell again by another penny to 19 cents in 1963. In one of the more important segments of American manufacturing, the automobile industry, the steel industry had not only a large relative decline but an actual small absolute decrease.

Farm machinery (44) is another industry where growth in the 17 year period was very modest, rising 30 per cent from 2,366 million dollars in 1947 to only 3,080 million dollars in 1963. Steel use fell dramatically from 1947 to 1958 with only a partial recovery resulting from the economic upsurge of the early sixties. By 1963 steel use was down 72 million dollars (14 per cent) from its 1947 high of 496 million dollars. The direct and total requirements coefficients confirm the reduction of steel as a farm machinery input. In the initial twelve years direct requirements fell from 21 cents to 14 cents and total requirements dropped to 25 cents from 37 cents. In the 1958-1963 era the relative drop in steel use was fairly small but may be considered important as absolute steel use rose by 57 million dollars during this period.

The construction, mining, and oil field machinery equipment industry (45) was almost stagnant in the 1947-1958 period. This probably reflects the problems in coal mining during the fifties. During the early sixties this industry turned upward and showed a modest growth from 3,085 million dollars in 1958 to 4,062 million dollars in 1963. Relative use of steel as an input fell throughout the period under consideration. Not only did steel use fall during the industry's period of stagnation in the fifties, but when the industry recovered, steel use remained constant. By 1963 the quantity of steel used per dollar of output had fallen about 5 per cent from 1947. Similarly, total requirements of steel fell 9 per cent from 30 to 27 cents per dollar of delivery to final demand in the construction, mining, and oil field machinery industry.

The next four industries, the material handling machinery and equipment industry (46), the metalworking machinery and equipment industry (47), the special industry machinery and equipment industry (48), and the general industrial machinery and equipment industry (49), can be treated as a group. All four industries are engaged in producing investment machinery. In general, each industry experienced almost no growth in the 1947-1958 period. With the exception of the special machinery and equipment industry, they staged modest comebacks during the 1958-1963 era. While individually each industry's consumption of steel seems small relative to the other industries considered so far, collectively they increased their consumption of steel from 1,109 to 1,544 million dollars in 17 years. While these four industries did not grow as rapidly as the economy did during the period under study, it might be expected that, in these industries that compose the backbone of the capital requirements sector of American industry, steel would maintain its importance. However, between 1947 and 1958 both the direct and total steel requirements fell by 5 to 10 per cent. Except for the materials handling machinery and equipment industry, which remained constant in relative steel usage, the industries did increase the relative use of steel in the five years after 1958. However, only in the metalworking machinery and equipment industry was the upsurge of the last five years significant. In this industry the steel requirements per dollar of delivery to final demand rose by a penny resulting in a 3 per cent gain for steel in the entire period. In the other industries the revival of steel use was not sufficient to reverse the slide that had taken place in the 1947-1958 period. Both the special industry machinery and equipment industry and the general industrial machinery and equipment industry required 2 cents (9 per cent) less steel per dollar to final demand in 1963 than was needed in 1947. The results in these four important industries indicate two things. First, in an increasingly service oriented economy, the industries that formed the bulk of our economy's investment machinery needs are quite distinctly declining in their relative importance. Secondly, steel's importance in these industries is, at best, not changing.

The machine shop products industry (50) is one of the smaller industries to be considered in this study. It is used because of the illusory quality of the changes that have taken place in this industry. The value of machine shop products rose 221 per cent from 703 million to 2,257 million dollars between 1947 and 1963. Even during 1947-1958, the value of machine shop products showed a 128 per cent increase. However, for each dollar of output, the input of steel fell from 12 to 8 cents in the 1947-1958 era. While there was a half cent recovery in the following five years, the decline of steel use in the factor mix is unmistakable. The total requirements table confirms steel's market loss in this industry. In the 17 year period, there was a 26 per cent decline in steel needs from 21 cents to slightly over 15 cents per dollar of delivery to final demand.

The service industry machines industry (52) is interesting because it is the supplier of capital equipment for one of the more dynamic sectors of the United States economy. While its growth was modest in the 1947-1958 period (38 per cent), the industry's output grew by 50 per cent in the next five years from 2,254 to 3,391 million dollars in 1963. As in several other industries, the absolute quantity of steel used actually fell in the 1947-1958 period with only a 51 million dollar (32 per cent) upsurge in the last five years. As an input, steel diminished in importance throughout the entire period. Steel needs from both direct and indirect sources show a decline from 24 cents to 16 cents per dollar of final demand. In 17 years, while demand for service industry machines had increased by 107 per cent, total steel requirements had actually diminished by one third.

The electric transmission and distribution equipment and electrical industrial apparatus industry (53), which supplies most United States industrial electric generation equipment, has had a fairly impressive growth record over the period under study. Value of output rose from 4,026 million dollars in 1947 to 6,495 million dollars in 1963. In the first twelve years when this industry's output increased by 28 per cent, the amount of steel used actually dropped by 15 per cent (52 million dollars). In the last five years of the period under study, steel recovered only to its 1947 status in terms of value of product used. While the direct input of steel was not very high in 1947, steel's place was reduced from approximately 10 cents per dollar of output to slightly less than 6 cents in 1963. This large decline in steel use is also seen in the total requirements table. The need for steel in all electrical transmission and distribution equipment fell by 5 cents for each dollar of demand: a decline of one third in a 17 year period. As in many other of the industries examined, this industry increased its steel usage between 1958 and 1963. However, the recovery is slight, leaving steel in a less desirable position than in 1947.

The household appliances industry (54) grew with the economy during the 17 year period. From a 2,833 million dollar industry in 1947, it grew by 27 per cent to a 3,595 million dollar industry in 1958. After another five years the industry had grown to produce an output worth 4,673 million dollars. This represents a total increase in value of product of 65 per cent by 1963. Direct requirements of steel fell sharply: down by 34 per cent in 1958. Total steel requirements necessary to produce a dollar of final demand in household appliances reflect the same trend. While the shift out of steel slowed considerably in the 1958-1963 era, the overall impact of the decline in steel needs was dramatic. Where 25 cents in steel was required for a dollar of final demand for household appliances in 1947, this had declined to less than 16 cents in 1958 and remained stable to 1963.

The electric lighting and wiring equipment industry (55) is another of the smaller users of steel. In the 1947-1963 period the value of this industry's output expanded from 1,898 million dollars to 3,081 million dollars: a 62 per cent increase. The growth in the first twelve years was rather slow; only a 21 per cent expansion in value of output took place, but the last five years brought about a 35 per cent increase in output. The electric lighting and wiring industry is interesting in that steel usage seemed to grow at a faster rate than did the industry as a whole. Steel used rose from 116 million dollars in 1947 to 155 million dollars in 1958 to 201 million dollars in 1963. This is reflected in the direct requirements table where the steel input rose by almost 70 per cent during the 17 years under analysis. However, the total requirements table reflects the fact that in this industry total steel requirements had actually fallen by 16 per cent. In 1947, each dollar of delivery to final demand by the electric lighting and wiring equipment industry stimulated slightly over 14 cents in steel production. By 1958 this had fallen to 12 cents where it remained in 1963.

The motor vehicles and equipment industry (59) represents the second industry selected to represent the automotive industry. It is one of the larger steel users examined in this study. Its growth record is impressive particularly between 1958 and 1963, when the value of output rose from 23,469 to 50,031 million dollars. The 1963 output was 110 per cent of 1947 output. Steel usage did not keep up with the industry. In terms of direct inputs, the motor vehicles and equipment industry used 3 cents less per dollar of output in 1963 than in 1947. The total requirements table indicates the complete impact of the relative decline of steel usage by this industry. In 1947 a dollar of demand required 26 cents in output from the steel industry. By 1958 this had fallen 23 per cent to 20 cents. While there was a slight recovery by 1963 to 21 cents per dollar of final demand in the motor vehicles and equipment industry, there was a net decline of 19 per cent in total relative steel needs during the period under analysis. The overall impact of a decline in relative steel needs is extremely important for an industry as large as motor vehicles and equipment. In terms of direct requirements only, another 1,000 million dollars of steel would have been necessary in 1963 if the motor vehicles and equipment industry had not changed its factor mix significantly.

The aircraft and parts industry (60) had a fantastic record of growth during the 17 years under analysis. This is due primarily to the growth of both a large private airline industry and spending on military aircraft. The 2,498 million dollars generated in this industry in 1947 rose by 473 per cent to 14,317 million dollars in 1963. Steel as an input fell by the wayside during this period. In fact, between 1958 and 1963 the quantity of steel fell absolutely by 22 per cent from 405 million dollars to 315 million dollars. Per dollar of output, direct requirements of steel fell from 7 to 3 cents in 1947-1958 to 2 cents in 1963. The change in total requirements of steel for the aircraft and parts industry is even more dramatic. In 1947 a dollar of delivery to final demand required 26 cents in steel production. By 1958 this was down 67 per cent to 9 cents of steel and finally in 1963 only 7 cents of steel was required. In one of the fastest growing industries in the United States, steel needs declined dramatically. In the last five years of the study, steel use diminished both absolutely and relatively.

The last industry considered is the other transportation equipment industry (61). Overall the performance of this industry was not very good. This is because a large segment of the industry is composed of shipbuilding, locomotive, and railroad equipment which were depressed sectors during the period of this study. Growing industries like boat building, motorcycles, and trailer coaches were too small to overcome the downward push of the other parts of this industry. Production was valued at 7 per cent less in 1958 than in 1947. By 1963 value of output was up only to 4,894 million dollars from 4,077 million dollars in 1947. The impact on steel usage in the industry followed the trend of many other steel users. There was a large swing out of steel as an input between 1947 and 1958, and then a slight gain between 1958 and 1963. The overall impact, however, was to diminish the importance of steel in the production of transportation equipment. Total requirements of steel fell 18 per cent from 27 cents to 22 cents per dollar of delivery to final demand in the 1947-1958 period. The slight recovery to 23 cents in 1963 still resulted in an overall 14 per cent decline in total steel requirements for this part of the transportation equipment industry.

III. DOMESTIC STEEL SUBSTITUTES

The other important aspect of the relative decline in steel usage is the new composition of inputs. Unfortunately, as both relative prices and technology have gone through major shifts in the economy, it is almost impossible to identify the causal relationship behind these shifts and the impact of these shifts on steel.

However, it is of some value to view the progress of several other industries that produce steel substitutes during the same 1947-1963 period of time to see if these industries increased their services to the major buyers of steel. In the 1957 hearings in Congress on steel, Roger M. Blough, Chairman of the Board of the United States Steel Corporation, stated:

> To persist in the discredited assumption that there is an absence of competition in steel is to renounce reality and to cling to delusion.
>
> Let us not forget, moreover, that, rigorous and successful as United States Steel's competitors have been, they are by no means the only competition which we must meet in selling steel. With the American wage rate three times as high as those which are paid to steelworkers abroad, we face increasing competition from foreign

imports, and in certain product lines this competition has cut heavily into our market.

Beyond that, too, is the intense competition that steel faces from other industries producing a host of products that can be used as substitutes for steel. Thus aluminum is striving mightily to replace steel in the automotive market, in the building industry, and in containers. Plastics are contending against steel in the manufacture of pipe and for hundreds of other uses. . . . The steel we produce for the manufacture of tin cans competes against glass, paper, and other substances. In the construction field, steel must vie with prestressed concrete, wood, masonry, slate, asbestos, and other materials too numerous to mention. And always it must compete against other metals such as copper, bronze, lead, magnesium, and so on.[6]

The problem of increasing international rivalry in steel production is discussed in Chapter IV. At this point, Roger Blough's statement serves as an excellent criterion for identifying those industries that pose the greatest competitive threat to the steel industry. From the input-output organization of industries, five have been chosen to illustrate steel substitutes. The five industries are the lumber and wood products (except containers) industry (20), the plastics and synthetic materials industry (28), the glass and glass products industry (35), and the stone and clay products industry (36), and the primary nonferrous metals manufacturing industry (38).[7]

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[6]United States Congress, Senate, Committee on the Judiciary, Steel: Administered Prices, Part 2, Hearing before the Subcommittee on Antitrust and Monopoly, 85th Congress, 1st Session, August 8, 1957 (Washington: Government Printing Office, 1958), p. 209.

[7]For further explanation of the components of these five industries, and their Standard Industrial Classification, see Table A-1 in Appendix A.

The results are not very conclusive of any dramatic shift to the industries mentioned by Mr. Blough. In new construction (11), the relative shift out of steel is matched by a shift out of wood products. Only the stone and clay products industry has made a successful penetration of this industry in the 17 year period. Plastics and synthetic materials improved their position but still were stimulated to less than a penny's worth of production for each dollar in final demand in new construction.

In the ordnance and accessories industry (13) the result is correspondingly ambiguous. The relative decline of steel is almost matched by a decline in the nonferrous metals manufacturing industry. The other industries are extremely small suppliers. Total requirements of plastics rose significantly in percentages, but in 1963 still remained less than 1 cent in plastic required per dollar of final demand in ordnance.

In the four industries related to transportation (43, 59, 60, 61), the results are only slightly better. The direct requirements of nonferrous metals and plastics were up somewhat except in motor vehicles and equipment. In terms of total requirements, the plastics and synthetic materials industry increased by a significant percentage in all four industries by 1963. However, at best it was only 1.5 cents per dollar of delivery to final demand in the motor vehicles and equipment industry in 1963. While primary nonferrous metal also made some gains in these industries, the results were not significant enough to warrant hypothesizing that this was the result of direct substitution out of steel.

The other furniture and fixtures industry (23) showed growth in the total requirements necessary from the five industries under consideration. However, in this case steel requirements remained almost stable through the 1947-1963 period.

In the six machinery industries (44-49) some effect of substitution is visible. Except for farm machinery, by 1963 the amount of primary nonferrous metals required per dollar of delivery to final demand had increased from 2 to 3 cents for each of the machinery producing industries. Plastics also made gains in these industries from 1947 to 1963. In 1947 a dollar of final demand required .3 cent in plastics. By 1963 this was up to a cent per dollar of demand in four of the six industries.

Four industries illustrate some of the increased competitiveness of substitute products. For the service industry machines industry (52), total requirements of both plastics and nonferrous metals increased between 1947 and 1958 and increased again by 1963. However, the increased competitiveness of these products displaced several other products as well as steel. In the electric transmission and distribution equipment and electrical industrial apparatus industry (53), plastics and nonferrous metals made similar, if small, gains in total usage. In the household appliances industry (54) both plastics and glass made significant inroads in total requirements. Finally, the electric lighting and wiring equipment industry (55) increased its total requirements of plastics and nonferrous metal between 1947 and 1963 while steel declined relatively.

Two points should be made concerning the impact of these steel substitutes. First, it is not possible to isolate the exact impact of substitutes on steel over the 17 years under analysis. This is due to the problem that when the factor mix changes for several inputs, it is impossible to isolate how relative price changes or technology changes actually cause the rearrangement of the factor mix. In fact, rigid technological interrelatedness might cause the quantity of the factors to remain constant while changing prices merely reorganize the value of the factor mix.

Second, it is important to note that the steel substitutes fared somewhat better than did the steel industry during the 1947-1963 period. Also all five of these steel substitute industries had excellent growth records between 1947 and 1963. While the value of steel output had risen 14 per cent, these five industries did significantly better. Glass and glass products had the poorest record. This industry's value of output rose only 48 per cent from 1,980 million dollars in 1947 to 2,932 million dollars in 1963. The lumber and wood products industry was next. It grew from 7,122 million dollars in 1947 to 10,654 million dollars in 1963: a 50 per cent increase in value of product. The primary nonferrous metals manufacturing industry grew by 89 per cent from 7,563 million dollars in 1947 to 14,272 million dollars in 1963. Stone and clay products rose in value by 113 per cent from 4,491 million dollars in 1947 to 9,548 million dollars in 1963. The plastics and synthetic materials industry had the best record of growth. Value of product rose 267 per cent in the 17 year period. In 1947 it was only 1,729 million dollars and in 1963 it was 6,341 million dollars.

Thus, while expansion of these five industries in the sector where steel has dominated was not noteworthy, each grew significantly, expanding into various sectors that may have had a potential for increased steel use.

IV. SUMMARY OF THE FINDINGS

While it must be taken into consideration that one of the years of study, 1958, will bias the data somewhat, due to the many economic ills of that year, the input-output data for 1947, 1958, and 1963 provide significant verification of steel's increasing difficulties in the United States economy. There are several important aspects to the findings that should be summarized.

First, the twenty-three industries selected for study significantly increased the percentage of the value of total intermediate output that they used. In 1947 these twenty-three industries used 84 per cent; in 1958, 91 per cent; and in 1963, 90 per cent of the value of total intermediate output. Thus, these industries played a more important role at the end of the period of analysis than at the beginning. Their dominance of American steel output was more complete, and steel's dependence was therefore more complete.

Second, between 1947 and 1958 only five of the twenty-three industries grew by a greater percentage than the economy as a whole did. These industries were new construction (11), ordnance and accessories (13), heating, plumbing and fabricated structural metal products

(40), machine shop products (50), and aircraft and parts (60). In all five of these industries, there was a pronounced shift in the use of steel. Each industry used substantially less steel as an input by 1958. In terms of total requirements, new construction had the smallest decline in steel needs: an 11 per cent fall in steel required per dollar of delivery to final demand for construction.

In the 1947-1958 period, only three industries increased the relative size of their steel inputs. They were other furniture and fixtures (23), other fabricated metal products (42), and electric lighting and wiring equipment (55). Only the fabricated metal products industry is a very large steel user (1,262 million dollars in 1958). The other two both used less than 200 million dollars of steel in 1958. Each of these industries had a growth record smaller than the economy as a whole. In the case of electric lighting and wiring equipment, only direct requirements of steel increased. Total steel production stimulated by increased demand in this industry actually fell by 16 per cent.

In those five industries, new construction (11), primary iron and steel manufacturing (37), heating, plumbing and fabricated metal products (40), other fabricated metal products (42), and motor vehicles and equipment (59), that used over a billion dollars of direct steel in 1958, only the other fabricated metal products industry increased either its direct or total requirements of steel. The other four all experienced a relative shift out of steel. Of these five industries, the one that increased its relative use of steel was the smallest in terms of dollar value of total output.

Between 1947 and 1958, steel shipped an increasing share of its output to a series of industries that, taken as a whole, performed less well than the economy, and that, viewed collectively, were slowly shifting out of steel as either a direct or indirect input. Steel's buyers had contracted relative to the economy and steel use had contracted relative to its buyers.

Third, the total period of 1947-1963 showed the same overall trend even though 1963 was a far healthier year for the economy than was 1958. In this case seven of the industries had grown by a larger percentage than the economy. They were new construction (11), ordnance and accessories (13), other fabricated metal products (42), machine shop products (50), service industry machines (52), motor vehicles and equipment (59), and aircraft and parts (60). In only one case, the other fabricated metal products industry, was there an insignificant shift out of the total requirements of steel for a dollar of delivery to final demand. In this one case, direct requirements are actually increased in the 17 year period from 15 cents in 1947 to 17 cents in 1963: a 14 per cent increase. The other six industries all reduced their dependence on steel significantly from a low of a 19 per cent decline in the total steel required to fulfill a dollar of demand in the motor vehicles and equipment industry to a high of -74 per cent change in the total steel requirements of the aircraft and parts industry.

In the 1947-1963 period, only five industries increased the relative size of their direct steel input. They were other furniture and fixtures (23), screw machine products, bolts, nuts, etc. and metal stampings (41), other fabricated metal products (42), metalworking machinery and equipment (47), and electric lighting and wiring equipment (55). Most of the increases were small, ranging from 3 per cent in the screw machines products, bolts, nuts, etc. and metal stamping industry to 14 per cent in the other fabricated metal products industry. However, while each of these industries increased its direct steel input, only the metalworking machinery and equipment industry stimulated more steel production in 1963 than in 1947. Even this improvement in steel requirements per dollar of delivery to final demand actually fell. The impact of increased direct steel usage is therefore nullified; it is an advantage only when indirect changes in the factor mix are ignored.

In 1963 there was one additional industry that used more than one billion dollars of direct steel than there were in 1958. It was the screw machine products, bolts, nuts, etc. and metal stampings industry (41), with total direct steel purchases of 1,047 million dollars. This industry and the other fabricated metal products industry are the only two to show increases in direct input of steel. Between 1947 and 1963 none of these six industries increased the total steel required per dollar of delivery to final demand.

The trend from 1947 to 1958 was not substantially altered in 1963. The basic steel users in the economy did not match the growth of the gross national product in the 1947-1963 era. These industries continued to use relatively less steel, and the decline in steel needs was in several cases substantial. A final note should be made concerning the 1958-1963 changes in both the direct and total requirements coefficients. In nine cases, while both the 1947-1958 change and the 1947-1963 change showed a relative decline in steel usage, there was a relative increase in steel usage in the 1958-1963 period. Taking into consideration the overall lack of prosperity in 1958, these changes were fairly insignificant. What is more important is the fact that even given the fact that 1958 was a recessionary year, most of the industries still decreased their total steel requirements again in 1963.

Fourth, while the direct impact of domestic substitutes for steel on American steel production cannot be clearly demonstrated, each of the five industries considered grew more quickly than the steel industry. From the relatively poor growth record of the glass and glass products industry to the excellent growth record of the plastics and synthetic materials industry, each of these five steel substitute producers penetrated the traditional steel buying industries; and, more importantly, each industry significantly expanded output into other sectors of the economy where steel might have experienced growth.

CHAPTER IV

INTERNATIONAL STEEL REQUIREMENTS AND THE UNITED STATES INDUSTRY

In the domestic market, the steel industry has not fared well. There are good indications that the basic steel product is facing both increasing substitutability with other related products such as plastics, concrete, various nonferrous metals, etc., and a decreasing income elasticity of demand as the economy matures.

Internationally, the United States steel industry seems to be plagued with a similar situation. Domestic production of steel rose from 84,894 thousand net tons in 1947 to 112,715 thousand net tons in 1957 to 141,262 thousand net tons of steel in 1967.[1] However, as Table IV-1 illustrates, United States steel lost over half of its world market during this same time period. In 1947, the United States controlled 57.1 per cent of the world market. This fell to 35.2 per cent in 1957 and to 22.5 per cent in 1969. While American steel production increased by 66 per cent between 1947 and 1969, there was a significant decline in American market power because world production of steel increased by 417 per cent.

The decline of United States steel in the international market was not solely the result of the reconstruction of the industries which

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[1]American Iron and Steel Institute, Annual Statistical Report (New York: American Iron and Steel Institute, 1969 edition).

TABLE IV-1

RAW STEEL PRODUCTION--WORLD COMPOSITION

(Percentage of Total World Steel Production)

Year	World steel production (thousands of net tons)	United States	Japan	ECSC	United Kingdom	U.S.S.R.	Mexico Argentina Brazil	Australia	Canada
1969	628,793	22.5	14.4	18.8	4.7	19.2	1.7	1.2	1.6
1968	582,548	22.6	12.7	18.7	4.9	20.2	1.8	1.2	1.9
1967	547,600	23.2	12.5	18.1	4.9	20.6	1.6	1.3	1.8
1966	519,124	25.8	10.1	18.1	5.2	20.6	1.6	1.3	1.9
1965	503,083	26.2	9.0	18.8	6.0	19.9	1.5	1.2	2.0
1964	479,025	26.5	9.2	19.1	6.1	19.6	1.5	1.2	1.9
1963	422,239	25.9	8.2	19.1	6.0	20.9	1.5	1.2	1.9
1962	394,254	24.9	7.7	20.3	5.8	21.3	1.4	1.2	1.8
1961	390,062	25.1	8.0	20.7	6.3	20.0	1.3	1.1	1.7
1960	381,582	26.0	6.4	21.0	7.1	18.9	1.2	1.1	1.5
1959	337,173	27.7	5.4	20.6	6.7	19.6	1.1	1.1	1.8
1958	298,878	28.5	4.5	21.3	7.3	20.2	1.0	1.2	1.5
1957	320,575	35.2	4.3	20.5	7.6	17.5	.8	1.1	1.6
1956	310,840	37.1	3.9	20.1	7.4	17.0	.8	.9	1.7
1955	297,222	39.4	3.5	19.5	7.5	16.9	.7	.8	1.5
1954	245,678	38.9	3.5	19.6	8.4	18.3	.8	1.0	1.3
1953	258,300	43.2	3.3	16.8	7.6	16.2	.7	.9	1.6
1952	232,735	40.0	3.3	19.8	7.9	16.6	.7	.8	1.6
1951	230,780	45.6	3.1	18.0	7.6	14.9	.7	.7	1.5
1950	207,829	46.6	2.6	16.9	8.8	14.6	.6	.6	1.6
1949	176,268	44.2	1.9	17.9	9.9	14.8	.7	.7	1.8
1948	168,243	52.7	1.1	--	9.9	10.8	--	--	1.9
1947	148,597	57.1	.7	--	9.6	10.4	--	--	2.0
1946	121,562	54.8	.5	--	11.7	11.8	--	--	1.9

Source: American Iron and Steel Institute, Annual Statistical Report (New York: American Iron and Steel Institute, 1969-1956 editions).

were damaged or destroyed by World War II. Table IV-1 indicates that while Japan and the U.S.S.R. made significant gains in steel production, these gains do not represent a complete displacement of the losses of the United States and the United Kingdom. Of interest is the fact that the nations of the European Coal and Steel Community have remained producers of one fifth of the world's steel since 1950--even in the face of the fact that the Western European steel producers were among the principal innovators in the post-World War II era. The increased steel production came from many previously small steel or non-steel nations. The entry of these nations into the world steel market is reflected in the export-import pattern in the United States. In 1957, the United States exported 6,008 thousand net tons of steel products to the rest of the world, while importing only 1,320 thousand net tons of steel products. By 1968 the figures were reversed. The United States exported only 2,499 thousand net tons while imports had risen to 18,462 thousand net tons of steel products, although this dramatic reversal was somewhat reduced by the impact of the international cartel in 1969.[2]

Several new elements had been added to the world steel market. These new conditions tended to complement the domestic trend. United States steel faced a decline in market position both domestically and internationally.

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[2] *Ibid.*

I. THE INTERNATIONAL PRODUCT CYCLE AND NATIONAL STEEL SUFFICIENCY

Internationally, steel has gone through a product life cycle. As a product, steel has changed in its basic market characteristics. The market for a product varies significantly depending on its age. There is a qualitative difference if the product has just been introduced to the market or if it is a product with a long production history. Raymond Vernon has developed a theory of international trade based on the product cycle that is particularly useful in the analysis of the steel industry.[3] Vernon attempts to place the growth of industries and international trade in a behavioral context. Vernon believes that if the assumption of perfect knowledge is relaxed, the organization of the market will be significantly affected. He points out that the time gap between scientific invention and innovational implementation by an entrepreneur is large. The former is easily communicated throughout the world, while the latter is heavily dependent on the vagaries of the market in different parts of the world.

> It [the product cycle thesis] puts less emphasis upon comparative cost doctrine and more upon the time of an innovation, the effects of scale economies, and the roles of ignorance and uncertainty in influencing trade patterns.[4]

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[3]Raymond Vernon, "International Investment and International Trade in the Product Cycle," Quarterly Journal of Economics, Vol. 80 (May, 1966), pp. 190-207.

[4]*Ibid.*, p. 190.

The growth and development of a market is motivated not merely by available technology and the availability of low cost inputs but also by the organizational structure of the market in terms of decision making within which the innovating entrepreneur resides. The search for market innovation is motivated. The process of development of a market represents an application of Cyert and March's problemistic search.

> By problemistic search we mean search that is stimulated by a problem and is directed toward finding a solution to that problem. In a general way, problemistic search can be distinguished from both random curiosity and the search for understanding. It is distinguished from the former because it has a goal, from the latter because it is interested in understanding only insofar as such understanding contributes to control.[5]

The perfect knowledge assumption implies a type of motivation that can most accurately be called a search for understanding: a type of search more properly associated with the work of a pure scientist than with the practical goals of an entrepreneur. The art of the entrepreneur is his ability to exploit and to develop the practical implementation of invention. However, without knowledge of market potential, the entrepreneur has no incentive to innovate or to produce. Vernon summarizes with:

> There is good reason to believe, however, that the entrepreneur's consciousness of and responsiveness to opportunity are a function of ease of communication; and farther, that ease of communication is a function of geographical proximity.[6]

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[5]Richard M. Cyert and James G. March, _A Behavioral Theory of the Firm_ (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), p. 121.

[6]Vernon, _op. cit._, p. 192.

The behavioral relations of problemistic search and uncertainty avoidance help explain why the United States has led in developing new products and why United States dominance of a market will tend to fade with time, regardless of relative costs. Vernon offers two reasons why the United States usually moves first to exploit the profitability of a new product. First, income in the United States is relatively high. This provides the entrepreneur a chance to offer a new product to a large market--one that is most likely to be responsive to high income level wants. Secondly, high labor costs (consumer income) and a relatively free and abundant capital market in the United States stimulate both a need and a market for new products.[7]

The development of new markets and their location can not be traced merely to a surplus of innovational talent or to the low cost characteristics of production. New products are differentiated and do not have an established function for the user. In this case, the need for effective communication between the potential market and the potential supplier is very important.

"The [new] product itself may be quite unstandardized for a time; its inputs, its processing, and its final specifications may cover a wide range."[8] However, the product will mature in time, and the market for the product will probably change dramatically.

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[7] Ibid.

[8] Ibid., p. 195.

The process of change from a new or pioneer product to a standardized commodity will influence pricing patterns and marketing criteria. Joel Dean lists several characteristics of the maturing product. The three main indications that the product has moved to maturity in its life cycle are (1) the weakening of brand preferences, (2) the narrowing of physical variation, and (3) the stabilization of production methods.[9] In general, the product becomes more homogeneous and its uses become more varied. Attempts at illusory product differentiation will tend to increase. But the market will judge the mature product through fairly standardized performance criteria. Durable investment goods, in particular, tend to be standardized by engineering specifications. The mature product presents a less complex market with less uncertainty. Entry is facilitated with a resultant increase in the competitive features of the marketplace.

At the turn of the century steel was a relatively new and differentiated product. The producers of this new commodity attempted to minimize uncertainty by locating and developing plant efficiency in close proximity to the commodity's potential market. The United States steel industry developed in this pattern. The United States was one of the early developers of a large steel facility, and it paved the way for the standardization of basic steel in the international market through its development and exploitation of the large American market.

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[9]Joel Dean, Managerial Economics (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1951), pp. 424-427.

Several factors have helped in the promotion of increased international steel capacity and the resultant increase in international competition. The standardization of basic steel has increased price consciousness on the part of buyers. Nationalistic loyalties to certain productive facilities wane in this atmosphere. Standardized steel favors nations with low wage labor, particularly as technical ability transfers to the international domain. There is an indication--as developed in Chapter III--that the demand for steel has a declining income elasticity at very high levels of income. The development of an affluent economy in the United States places the United States industry in a stagnant market while steel needs are growing rapidly in the developing world.

The identification of industrialism and military might with a large steel facility inspires less developed nations to attempt to achieve some level of parity. Almost without exception, nations are willing to proceed with the increased search, and are willing to accept the costs of information in order to achieve some level of self-sufficiency in steel production. Thus the jingoism of the American steel industry as expressed by the American Iron and Steel Institute is readily transferrable to most nations of the world.

"It is generally understood that a ready supply of a wide variety of steel mill products is essential to the welfare of the U. S. economy and the national security."[10]

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[10]American Iron and Steel Institute, The Steel Import Problem (New York: American Iron and Steel Institute, 1969), p. 49.

For the United States and the world, the process of market change in steel is proceeding as the product matures and is standardized. Vernon sketches the pattern that occurs in the process of product maturation.

> In the international investment field, threats appear in various forms once a large-scale export business in manufactured products has developed. Local entrepreneurs located in the countries which are targets of these exports grow restive at the opportunities they are missing. Local governments concerned with generating employment or promoting growth or balancing their trade accounts begin thinking of ways and means to replace the imports.
>
> The uncertainty can be reduced by emulating the pathfinding investor and by investing in the same area; this may not be an optimizing investment pattern and it may be costly, but it is at least disturbing to the status quo.
>
> In speculating about future industrial exports from the less-developed areas, therefore, we are led to think of products with a fairly clear-cut set of economic characteristics. Their production function is such as to require significant inputs of labor. . . . At the same time, they are products with a high price elasticity of demand for the output of individual firms. . . . In addition, products whose production process did not rely heavily upon external economies would be more obvious candidates than those which required a more elaborate industrial environment. The implications of remoteness also would be critical; products which could be precisely described by standardized specifications and which could be produced for inventory without fear of obsolescence would be more relevant than those which had less precise specifications and which could not easily be ordered from remote locations.[11]

This approach admittedly disregards the importance of factor supply in the development of a steel industry and the necessity of steel to further industrialization of an economy. Basic steel is an excellent illustration of a commodity which has passed through an international

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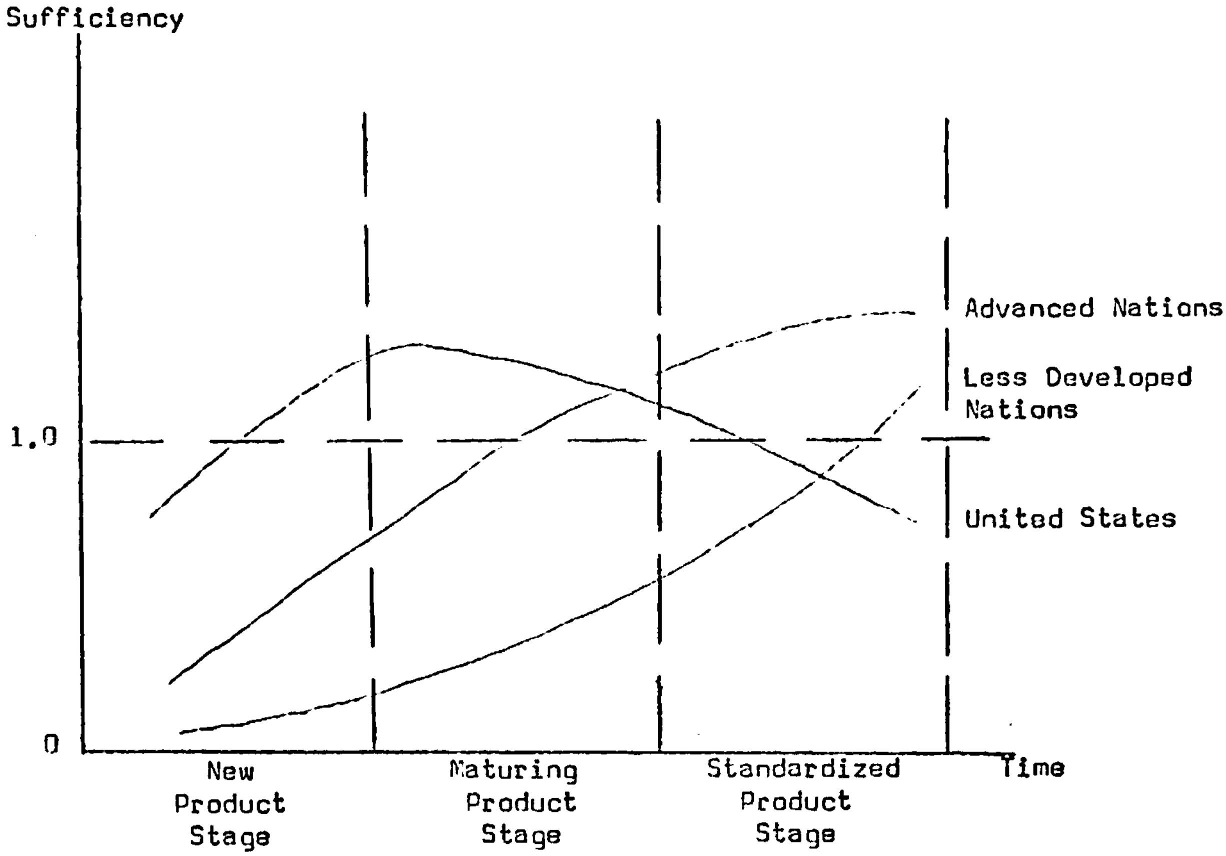
[11]Vernon, op. cit., pp. 200-201, 203-204.

product cycle. The process of standardization is based primarily upon improvement of communication over an expanding market.

Vernon divides the stages of product development among different types of countries, showing over time how improved communication changes a nation's export-import balance in the product. The cycle of a commodity can be illustrated by the diagram in Figure IV-1. The state of product development can be explained in terms of a sufficiency coefficient: the ratio of a nation's crude steel production to apparent consumption. The pioneer of a new product finds an early chance to export the product, i.e., the sufficiency coefficient is greater than one. As other industrialized nations advance, they should achieve a substantial export surplus as the product matures. The process of product development should partially eliminate the advantage of the pioneer country, lowering its sufficiency ratio. As the product becomes standardized, the economic advantages of the less developed world should result in increased sufficiency, while lowering the pioneer country's sufficiency coefficient as production facilities shift out of the innovating country.

The drive to sufficiency can be illustrated by two aspects of a nation's changing steel capacity. First, increased production, per se, will allow for further development of the manufacturing sector without total dependence on imports. The initiation and expansion of production facilities is a good indication of the spread of steel technology and the importance attributed to it in the growth process.



$$\text{Sufficiency Coefficient} = \frac{\text{National Production of Crude Steel}}{\text{Apparent National Consumption of Crude Steel}}$$

FIGURE IV-1

INTERNATIONAL PRODUCT CYCLE FOR STEEL

Secondly, most nations seem to be attempting to achieve self-sufficiency in steel production: matching output with apparent consumption. The process of approaching sufficiency illustrates both the emulation of the industrial nations by the less developed and the transfer of steel capacity from the innovating nations to nations with new found steel production ability.

The post-World War II era can be used to test the product cycle hypothesis in steel. Steel was a mature product with almost a century of development in the advanced nations. However, due to war, the United States had the only large steelmaking facility intact. In the 1947-1967 era, the nations of Europe and Japan rebuilt their steel-making facilities. Under pressure for rapid industrialization, the less developed world began erecting steel facilities. The result is an excellent example of the innovators being supplanted by copiers. This study examines the changing world steel sufficiency during a period following World War II when steel had become a standardized product.

Table C-1 in Appendix C illustrates the changes in steel sufficiency in the 1947-1967 period for several nations. They are divided into three categories: (1) the United States, (2) the other advanced nations, and (3) the less developed nations. The steel sufficiency coefficient for each year provides a useful index of nations' changing status in the world steel community. The world is somewhat arbitrarily divided into the above categories.[12] The United States is listed as the only pioneer steel producer, as most other nations (except the United Kingdom) suffered substantial destruction of their production facilities during the war. The second category of advanced nations includes most of Europe, the U.S.S.R., and Japan. A problem arises that while most of these nations can easily be categorized as advanced in terms of national income, many did not and do not have large steel producing facilities. As would be expected, the small steel producers seem to have different characteristics than the big steel producing nations that merely rebuilt after the destruction of World War II.

The third category, less developed nations, includes the steel producing nations of Africa, Asia, South America, and Southern Europe. Those nations that lack steel producing facilities are unimportant in comparing relative sufficiency levels.

As indicated in Chapter III above, the United States steel industry has not grown as quickly as the entire economy has grown. Between 1949 and 1967, apparent consumption of crude steel grew from 66,010 thousand metric tons to 126,187 thousand metric tons: a 91 per cent increase in the consumption of crude steel. However, production of crude steel rose at a much slower rate, resulting in a sufficiency

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[12] The grouping of nations into advanced or less developed generally follows the breakdown of the General Agreement on Tariffs and Trade (GATT) into industrial and nonindustrial economies. However, Greece, Portugal, Spain, and Turkey are classified as less developed nations in this study. The proximity of these nations to industrial Europe alone, considering their income levels, does not justify their inclusion among the advanced nations.

coefficient that fell from 1.072 in 1947 to 1.024 in 1958 to .915 in 1967. With the factors of production more expensive, United States industry found imports of steel more appealing, particularly as the price of this homogeneous good from another country fell below the American industry's supply price. The fall in the sufficiency coefficient of the United States should slow as the international cartel establishes itself as an international regulatory agency. Only the mystique of steel to advanced nations has maintained the sufficiency coefficient so close to one.

Among the other advanced nations there has not been the same trend as there has been in the United States. The major steel producing nations in the prewar era were France, Germany,[13] Japan, the United Kingdom, and the U.S.S.R. In each nation the sufficiency coefficient has remained relatively stable, even during the rebuilding of the steel producing facilities in the immediate post-war era. In France, apparent steel consumption has grown at only a slightly faster rate than has production. In 1949 the sufficiency coefficient for France was 1.293. The coefficient has risen and fallen depending on each year's consumption, which is often erratic, but in 1967 France still maintained a sizeable steel export balance with a sufficiency coefficient of 1.096. Germany increased production from 9,156 thousand metric tons in 1949 to 36,744 thousand metric tons in 1967, while

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[13]As the major steel producing facilities of Germany were in that part of the country now known as the Federal Republic of Germany, the German Democratic Republic is ignored.

maintaining a sufficiency coefficient that was always greater than one. Japan increased production almost twenty-fold in the 1949-1967 period, starting with an annual output of 3,111 thousand metric tons, which rose to 62,154 thousand metric tons of crude steel. The United Kingdom, despite its reputation for obsolete plant and equipment and its administrative problems with the government, has maintained a fairly consistent sufficiency coefficient above 1.1. While production increased by only 54 per cent--the smallest increase of the major steel producing nations--the United Kingdom maintained a consistent percentage of production in exports. The U.S.S.R. increased production from 27,329 thousand metric tons in 1950 to 102,224 thousand metric tons in 1967. The Soviet Union--a command economy--maintained an almost constant sufficiency coefficient of 1.03, resulting in a small export surplus of steel. In each of these economies steel has regained its strength and is maintained as an export commodity.

Vernon maintains that if financing, technology, and economies of scale are available on an international basis, then labor costs will provide the incentive to move the production of a standardized product to less developed nations.[14] The low wage structure of Europe and Japan relative to the United States has probably assisted in the maintenance of their self-sufficiency.

The minor steel producers in the advanced nations have generally increased the level of steel sufficiency in the economy. Of these

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[14] Vernon, op. cit., p. 198.

countries Austria, Canada, The Netherlands, Norway, and Sweden have advanced most notably. Austria, while still only a small steel producer in 1967, increased its production from 835 thousand metric tons in 1949 to 3,023 thousand metric tons. During this period it was able to significantly increase its export balance by increasing the sufficiency coefficient from 1.158 in 1947 to 1.588 in 1967--with several better years in the early 1960's. Canada almost became a net exporter of steel during this period, increasing its sufficiency coefficient from .723 in 1949 to .968 in 1967.

The Netherlands and Norway had the most dramatic increases in sufficiency. The Netherlands increased consumption of steel more than three-fold, from 1,491 thousand metric tons in 1949 to 4,721 thousand metric tons in 1967, while increasing production to the degree that The Netherlands is very close to being steel sufficient. In 1947 the sufficiency coefficient was .287 and it rose steadily to .827 in 1967. Norway was a very minor European steel maker in 1947, producing only 77 thousand metric tons of crude steel. By 1967, Norway was supplying over half of its steel needs of 1,413 thousand metric tons, having increased the sufficiency coefficient from .120 to .559.

Sweden, like Canada, increased production of steel at a significantly faster rate than it increased consumption, in order to transform itself into a net exporter of crude steel. In 1949 the sufficiency coefficient was .642. By 1958 it has increased to .833 and was 1.029 in 1967.

The experience of these nations demonstrates that even countries within close proximity of major efficient steel producers will find it convenient to increase the percentage of steel usage domestically produced. The spread of technology, the growth of the market, and the relative cheapness of labor would seem to affect the minimum factor endowment of these nations.

Denmark and Finland have maintained their positions as minor steel producers. Both countries trebled output along with similar rises in apparent consumption. While neither country substantially increased its steel sufficiency in the post-World War II era, the maintenance of a steady proportion of steel needs in production by these countries is important.

The Belgium-Luxembourg steel complex is in a class by itself. It is a fairly large steel producer--one that increased output of raw steel from 6,115 thousand metric tons in 1949 to 15,197 thousand metric tons in 1967. However, it was one of the largest, in both relative and absolute terms, net exporters of steel in the 1949-1967 period. The sufficiency coefficient of Belgium-Luxembourg consistently ranged between 3 and 4, a ratio that meant in 1967 that this steel area had net exports of 11,017 thousand metric tons of crude steel.

Three relatively large steel producers, Czechoslovakia, Hungary, and Poland--all under the political and military influence of the U.S.S.R.--maintained very stable sufficiency coefficients for the few years that consumption data are available. This is consistent with the structure of a command economy. With the U.S.S.R., these three countries reflect the world trend among developing economies to mold development to steel sufficiency. Each of these countries had a sufficiency coefficient of slightly greater than one for the period for which information is available. Economic development is to some degree constricted by the nation's ability to expand its steel facilities. In spite of a fairly constant sufficiency coefficient, Czechoslovakia increased production of steel by 220 per cent after 1950, Poland by 311 per cent, and Hungary by 162 per cent.

As the market for steel has become international in scope, and as the basic product has become standardized, it is the less developed nations of the world that show dramatic increases in steel sufficiency. Problems, of course, occur in the less developed world. Political and cultural conflicts with the industrial process have caused a chaotic pattern of steel improvement in the third world.

The growth of steel in South America is illustrative of the pattern of the less developed world. Most of the industry's development in these countries has taken place since World War II. Thus, while Brazil increased its sufficiency coefficient from .725 in 1949 to .923 in 1967--with the growth path being very chaotic--this country managed to increase its production overall six-fold to 3,696 thousand metric tons in 1967. With apparent steel consumption at 4,005 thousand metric tons in 1967, Brazil rivaled several of the minor European steel producers in steel needs.

Argentina and Mexico had the most success in developing steel sufficiency in South America. Argentina got off to a slow start, maintaining only slightly over 10 per cent of sufficiency during the 1950's.

However, in 1967 Argentina produced 1,325 thousand metric tons of steel: 65.3 per cent of sufficiency. Mexico is a particularly interesting country, since it became a substantial exporter of steel to the United States. In a steady pattern of growth, Mexico increased its steel sufficiency from 59.3 per cent in 1949 to 93.2 per cent in 1967. Mexico produced 3,060 thousand metric tons of steel in 1967--only slightly less than Brazil produced.

Chile pursued a rather chaotic path to sufficiency. Over the 19 year period, Chile built a small steel facility that consistently satisfied a large proportion of that country's steel needs. In 1967 Chile produced 88.6 per cent of 676 thousand metric tons of apparent steel consumption. Chile has maintained over 70 per cent of steel sufficiency since 1951.

Four countries in South America, Columbia, Peru, Uruguay, and Venezuela, began significant production of steel during the 1949-1967 era. Each of these countries is now able to satisfy a small proportion of its steel needs and has the basic technology for further expansion in the future.

Columbia began steel production in 1955, producing 77 thousand metric tons of the 335 thousand metric tons it needed. By 1967, Columbia had increased production to 207 thousand metric tons of crude steel, or 50.6 per cent of sufficiency. Peru initiated the production of steel in 1958. Production grew from 20 to 62 thousand metric tons in 1967--an extremely small steel facility but one which still satisfied about 20 per cent of Peru's steel needs.

Venezuela produced 50 thousand metric tons of steel in 1959, its first year of production. This rose to 690 thousand metric tons in 1967. In ten years this nation went from no steel production to a sufficiency coefficient of .575. The dramatic growth of sufficiency for this nation is partially due to the slow and chaotic fashion in which steel consumption grew. Uruguay is interesting only in that it began steel production in 1960. The increase in sufficiency for Uruguay is the result of an 80 per cent decrease in steel consumption between 1958 and 1967.

The second major area of development of steel production is in the less developed countries of Europe where five nations, Greece, Portugal, Rumania, Spain, and Turkey, represent the possibilities of growth of national steel production to compete with the developed steel economies in Europe. Greece is the only nation of the five where the growth of steel production was not steady. Initial data shows Greece produced 37.7 per cent of sufficiency in 1958. While consumption grew by 177 per cent in the next ten years, production rose from 113 thousand metric tons in 1958 to 210 thousand metric tons in 1965 and then retreated to 160 thousand metric tons in 1967. After a decade Greece was down to 19.2 per cent of sufficiency.

However, the other four nations present a different picture. Portugal initiated production in 1961. Production increased at a substantially faster rate than did consumption. In 1961 consumption and production were 539 and 68 thousand metric tons of steel respectively. By 1967 this gap had been narrowed to 654 and 316 thousand metric tons:

an increase in the sufficiency coefficient from .126 to .483.

Rumania is the one less developed nation under the political influence of the U.S.S.R. for which adequate steel production data are available. Rumania increased production of steel six-fold since 1950 from 555 thousand metric tons to 4,088 thousand metric tons in 1967. The sufficiency coefficient increased steadily from .540 in 1956 to .899 in 1966.

Spain was very erratic in its quest for steel sufficiency. It achieved sufficiency in the early sixties but fell as low as 55.8 per cent of sufficiency in 1966. However, crude steel production increased seven-fold from 729 thousand metric tons in 1949 to 4,335 thousand metric tons in 1967.

Turkey produced 100 thousand metric tons of crude steel in 1949: 51.5 per cent of sufficiency. Steel production grew continuously to 996 thousand metric tons in 1967. Unfortunately, the instability of apparent consumption of steel probably negates the usefulness of the sufficiency coefficient, although there is an indication that Turkey did slightly increase the proportion of industrial steel needs produced domestically.

Only four nations of the Middle East and Africa produce significant amounts of steel. They are Israel, the United Arab Republic, Southern Rhodesia, and the Republic of South Africa. Both Israel and the United Arab Republic began production in 1958 and each produced at about 10 per cent of sufficiency. Israel increased production from 24 to 84 thousand metric tons in 1966: an increase that resulted in 21.2

per cent of sufficiency, caused by a decline in steel consumption beginning in 1965. Through 1966, the United Arab Republic experienced a fairly rapid increase in both consumption and production of steel. Steel production, which was 28 thousand metric tons in 1958, was 195 thousand metric tons in 1966, representing an increase from 11.5 per cent to 24.1 per cent of sufficiency.

Both of the steel producing nations in the south of Africa have improved the proportion of steel needs domestically produced. Southern Rhodesia increased production from 23 thousand metric tons in 1950 to 130 thousand metric tons in 1966. The percentage of sufficiency rose from less than 20 per cent in the early 1950's to 42.2 per cent in 1966. The Republic of South Africa increased production six-fold from 636 thousand metric tons in 1949 to 3,651 thousand metric tons in 1967. In 1950 this nation produced 65.3 per cent of steel sufficiency. By 1959, the Republic of South Africa had achieved sufficiency.

Only six Asian nations have provided adequate information for establishing an index of sufficiency. Australia has an extremely important growing steel industry because of the recent ore finds in the northern provinces. Increases in steel production changed the sufficiency coefficient for Australia from .704 in 1949 to 1.193 in 1967. Actual production rose from 1,183 to 6,288 thousand metric tons of crude steel. Australia moved from a substantial importer of steel to a net exporter of steel in 19 years, while domestic consumption rose by over 200 per cent.

China and Taiwan have each increased steel production significantly.

However, China's path to steel sufficiency has been so chaotic that further comment is unjustified. Taiwan increased production from 14 thousand metric tons in 1950 to 443 thousand metric tons in 1967. However, production did not keep pace with apparent consumption. The sufficiency coefficient fell from a high of .848 in 1957 to .495 in 1967.

India has shown remarkable growth in steel sufficiency, considering the problems of modernization this country has faced. Production increased more quickly than did consumption, from 1,374 thousand metric tons of crude steel in 1949 to 6,380 thousand metric tons in 1967. Over this 19 year period, Indian steel production rose from 74.6 per cent to 99.6 per cent of sufficiency.

The two Koreas illustrate the possibilities of steel sufficiency in the poorest of the Asian nations. Destroyed by war in the fifties, North Korea had already achieved sufficiency in 1963--the first year for which information is available. The Republic of Korea began production in 1959 with 38 thousand metric tons, and production increased to 320 thousand metric tons in 1967. In 1967, South Korea produced 43 per cent of its steel needs.

In summary, steel has passed through an international product cycle. Vernon's thesis is verified by the data available in the years following 1949. As steel became a standardized product, the distribution of world steel production changed dramatically. As the United States declined in steel sufficiency, the other major steel producers in the advanced world seemed to reach a sufficiency plateau even though production continued to increase. Advanced nations with small steel facilities generally increased self-sufficiency in a process that remained fairly steady from 1949 to 1967.

The less developed world has been plagued by social, political, and economic instability in the era under consideration. Still, many nations substantially increased both steel usage and the percentage of usage produced domestically. Several less developed nations, including Australia, Mexico, and India, have reached a level at which large exports of basic steel are not possible.

The international product cycle is one of three factors in the present international steel market that has contributed to the disruption of the stability of the domestic market.

II. IRON ORE PRODUCTION

The basic input of the steel industry is iron ore. Of particular interest is the changing composition of this input in terms of world supply. One strength of the domestic industry in the United States has been its ability to integrate backward to the raw materials. Control over supply has allowed the industry to rationalize production and stabilize output.

Table IV-2 illustrates the composition of this vital input of the American industry. Shipments of domestic ore reached a peak in 1953. While a large effort has been made in recent years to improve the quality of domestic iron ores, the production and shipment of these ores seems to have reached a plateau. In contrast, the quantity of iron ore

TABLE IV-2

IMPORTS OF IRON ORE

(Thousands of Gross Tons)

Year	Imports	Total domestic shipments	Percentage of imports to total domestic shipments
1969	40,758	89,754	45.4
1968	43,941	81,934	53.6
1967	44,611	82,415	54.1
1966	46,259	90,041	51.4
1965	45,103	84,474	53.4
1964	42,408	84,300	50.3
1963	33,263	73,564	45.2
1962	33,409	69,969	47.7
1961	25,805	72,379	35.6
1960	34,578	83,783	41.3
1959	35,617	59,855	59.5
1958	27,833	67,067	41.3
1957	33,654	104,969	32.1
1956	30,358	97,897	31.0
1955	23,443	106,252	22.1
1954	15,782	76,918	20.5
1953	11,085	118,600	9.3
1952	9,761	97,972	10.0
1951	10,145	116,230	8.7
1950	8,216	97,764	8.4
1949	7,395	84,687	8.7
1948	6,086	100,275	6.1
1947	4,889	93,315	5.2
1946	2,813	70,090	4.0

Source: American Iron and Steel Institute, Annual Statistical Report (New York: American Iron and Steel Institute, 1969, 1967, 1963, 1958, 1953, and 1950 editions).

shipped from foreign origins to the United States rose continuously from 1946 to 1966.

Before 1952, iron ore imports accounted for less than 10 per cent of domestic shipments. Table IV-2 illustrates that the importance of imported ore has risen quite quickly. In 1967, foreign iron ore shipments were up to 54.1 per cent of the tonnage of domestic shipments: approximately a third of the domestic iron ore input supply. Combined with the industry's other problems, this change in the composition of input supply has helped to accentuate two trends within the industry.

First, improvements in technology have increased the importance of this raw material in the production process. The oxygen converter commands, at its present stage of development, a far greater charge of iron ore than do either the open hearth or electric furnace. One of the factors in furthering construction of electric furnaces on the seaboards of this country has been the relatively cheap supply of scrap steel that existed during the 1960's. From 1960 to 1969 the percentage of steel produced by the basic oxygen converter rose from 3.4 per cent to 42.7 per cent. This dramatic rise in basic oxygen capacity may please the critics of the industry but this change in production method has significantly increased the industry's dependence on foreign, albeit often domestically owned, ore.

Secondly, the flow chart in Figure II-1, page 69, interprets the importance of the new dependence on foreign iron ore within the behavioral context of United States steel's industrial structure. The locational advantage of the American industry was disturbed as it became dependent on more complex methods of transportation and on novel techniques of mining. Inherent in this shift in locational advantage is an increase in industrial uncertainty.

Problems of instability face the industrial coalition. Unfortunately, these problems can not be solved within the historical framework of the coalition. Integration backward into ownership of foreign ore fields usually only serves to transfer the uncertainty from the market to the individual firm. The process of industrial rationalization becomes more complex. Not only must domestic ore needs be taken into consideration, but the industry must face competition from other nations for control of the ore field and placate the nationalistic tendencies of the residents of the ore supplying country.

The origin of these imports, bringing the change in the input base, will also affect the industrial climate of the American steel industry. The most important iron ore supplier is Canada. In 1967 Canada exported 24,214 thousand gross tons of iron ore to the United States.[15] Over half of United States imports of iron ore came from Canada. The flow of Canadian ore into the United States has grown dramatically since 1946. In 1946, the American steel industry imported only 1,095 thousand gross tons of Canadian iron ore. This amount grew to a volume of 1,968 thousand gross tons in 1951, 13,720 thousand gross tons in 1956, 9,687 thousand gross tons in 1961, and 23,941 thousand

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[15] American Iron and Steel Institute, Annual Statistical Report (1969 edition).

gross tons in 1966. Imports of Canadian ore reached a peak of 26,338 thousand gross tons in 1968.[16]

While the absolute quantity of Canadian ore imported into the United States has fluctuated, the trend has been toward an increasing dependence on this iron ore input source. While Canadian ore does not present the locational problems of other imported iron ore, Canada has a growing steel industry with increasing iron ore needs. Canada was the first nation in this hemisphere to adopt the oxygen furnace--a steel-making process using a charge requiring a high percentage of iron ore.

South America has become an important source of raw material. In 1969 four countries, Brazil, Chile, Peru, and Venezuela, supplied 17,770 thousand gross tons of iron to the United States. However, Venezuela dominates the four. Shipments of Venezuelan ore began in 1951. From that date the shipments of ore to the American industry grew from 635 thousand gross tons to 9,245 thousand gross tons in 1956, to 10,478 thousand gross tons in 1961, to 13,751 thousand gross tons in 1969.[17]

While the United States has increased its consumption of South American ore, the local economies have increased their production and consumption of steel. In particular, three of the countries have had very dramatic growth trends in steel production. Brazil has the largest industry in South America, and with Chile seems to be close to achieving self-sufficiency (Table IV-2, page 130). Venezuela, largely due to the

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[16] Ibid. (1969, 1967, 1963, 1958, 1953, and 1950 editions).

[17] Ibid.

stimulus of the ore find, has increased its production from 50 thousand metric tons in 1959 to 690 thousand metric tons in 1967. Thus the United States, by increasing its dependence on South American ore, has run into potential long run conflict with the nations that are engaged in the process of industrialization. For example, in 1946, Mexico was only a modest exporter of iron ore to the United States. Today Mexico exports finished steel to the United States and competes with the other advanced steel producers for raw materials. If, in the process of industrialization, Venezuela, Brazil, and Chile emulate Mexico, a shortage of the ore input could become critical for the United States industry in the future.

In Africa, the primary source of ore for the United States is the rich fields in Liberia. These fields are still in the process of being developed. Iron was first imported from Liberia in significant amounts in 1951. The quantity rose from 110 thousand gross tons to 1,218 thousand gross tons in 1961. By 1969, the United States industry was importing 3,144 thousand gross tons of iron ore from Liberia.[18] While some of the other African states have substantial ore deposits, they tend to be tied to European producers. Marintania, a former French colony on the western African coast, has rich ore fields and in 1964 began exports to the United States. However, the American industry will face increasing locational problems in obtaining African ore, as the African nations, particularly the Union of South Africa, increase steel production.

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[18] Ibid.

Sweden was the main European supplier of foreign iron ore in the forties and early fifties. In 1946 Sweden exported 1,095 thousand gross tons of iron ore to the United States. The volume rose to a peak in 1951: 2,521 thousand gross tons. By 1956 it was down to 1,002 thousand gross tons, and in 1961 and 1969 only 78 and 155 thousand gross tons of ore were shipped to the United States from Sweden.[19] Europe, in general, now plays almost no role in supplying raw materials to the United States industry.

The recent discoveries of large iron ore deposits in northern Australia have yet to be exploited. However, the Australian industry and the booming Japanese industry control the rights to these ore fields. The development of the iron ore fields in Australia will reinforce the tendency of steel to move from the exclusive domain of the western states. The development of new ore fields in general reinforces the tendency of the less developed world to move toward sufficiency in steel while compounding the problems of the American industry.

III. EXPORTS AND IMPORTS OF STEEL

The changing raw material base, and increasing sufficiency of the rest of the world in steel production, has had an impact on the exports and imports of United States steel. During the fifties the United States enjoyed a substantial export surplus in steel. By the end of the 1960's the trade situation had more than reversed itself. In fact, it

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[19] *Ibid.*

is the reversal of the United States steel export position that has led most critics of the United States industry to investigate the importance of technological backwardness and oligopolistic market practices of the American industry.

As the examination of the development of world production demonstrates, the transfer of world steel capacity to developing low wage nations has changed the mix of needed production from the American steel industry. More nations have expanded production and have approached sufficiency, increasing the number of competitors in the world steel market. The bulk of United States exports in the fifties was in basic steel. It is in the area of semi-finished goods that standardization is easiest and technological transfer is more readily facilitated.

The international trade problem facing the American steel industry is illustrated in Tables IV-3 and IV-4. While steel production throughout the world has almost doubled since 1957, exports to the rest of the world between the 1957 peak and 1968 decreased by more than 50 per cent. Exports declined rapidly in the late 1950's. In 1968 only 2,170 thousand net tons of steel mill products were exported. In 1969 exports rose significantly; however, this radical departure from the trend can possibly be explained by the establishment of the international steel cartel in 1968.

Import penetration of the American market rose over time at a faster rate than did world steel production. Imports of iron and steel were 2,482 thousand net tons in 1953, 3,927 thousand net tons in 1961, and 19,563 thousand net tons in 1968. The greatest growth was in steel

TABLE IV-3

UNITED STATES EXPORTS OF IRON AND STEEL

(Thousand Net Tons)

Year	Total steel mill products*	Total other steel products**	Total iron products and ferroalloys***	Total
1969	5,229	368	343	5,939
1968	2,170	329	283	2,782
1967	1,685	287	196	2,168
1966	1,724	303	251	2,278
1965	2,496	341	252	3,089
1964	3,281	293	470	4,044
1963	2,180	332	290	2,802
1962	2,013	261	245	2,519
1961	1,989	239	558	2,786
1960	2,980	247	246	3,473
1959	1,508	517	78	2,103
1958	2,687	606	155	3,449
1957	5,176	831	946	6,953
1956	4,157	654	354	5,165
1955	3,870	585	97	4,553
1954	2,659	459	41	3,158
1953	3,079	219	47	3,345

*Steel mill products:
- Ingots, blooms, billets, slabs, etc.
- Wire rods
- Structural shapes (3" and over)
- Sheet piling
- Plates
- Rails--Standard
  - --N. E. C.
- Rail joints and tie plates
- Track spikes
- Wheels and axles
- Concrete reinforcing bars
- Bar shapes under 3"
- Bars--Hot rolled--Carbon
  - --Alloy
- Cold finished bars
- Tool steel
- Pipe--Black
  - --Galvanized
  - --Line

TABLE IV-3 (continued)

Oil country goods
Tubing--Pressure
  --Mechanical
Other pipe and tubing
Wire--Alloy and stainless
  --Carbon
  --Barbed
  --Fencing
  --Nails and staples
Black plate
Tin plate--Hot dipped and electrolytic
Circles, cobbles, and butts
Terne plate
Sheets--Hot rolled
  --Cold rolled
  --Enameling
Sheets and strip--Galvanized and other coated
  --Electrical
Strip--Hot rolled
  --Cold rolled

**Other steel products:
Plates--Fabricated
Structural shapes--Fabricated, sashes and frames
Relaying rails, railway track material
Bolts, nuts, screws, rivets, washers
Architectural and ornamental work, N. E. C.
Welding electrodes
Wire cable, rope, strand, springs and fabricated products
Containers
Sheets--Fabricated
Steel castings
Forgings
Chains and parts
Rigid conduit
Pipe and tube fittings

***Iron products and ferroalloys:
Chilled iron railway car wheels
Cast iron pipe and fittings
Iron castings
Pig iron
Ferroalloys

Source: American Iron and Steel Institute, Annual Statistical Report (New York: American Iron and Steel Institute, 1969-1953 editions).

TABLE IV-4

UNITED STATES IMPORTS OF IRON AND STEEL

(Thousand Net Tons)

Year	Total steel mill products*	Total other steel products**	Total iron products and ferroalloys***	Total
1969	14,034	581	829	15,443
1968	17,960	502	1,102	19,563
1967	11,955	470	889	12,813
1966	10,753	413	1,581	12,748
1965	10,383	366	1,214	11,964
1964	6,440	271	990	7,701
1963	5,452	212	863	6,527
1962	4,100	204	685	4,990
1961	3,164	158	604	3,927
1960	3,333	246	510	4,089
1959	4,392	274	850	5,516
1958	1,703	141	285	2,130
1957	1,154	167	554	1,875
1956	1,344	151	491	1,986
1955	976	115	376	1,467
1954	788	102	364	1,254
1953	1,721	31	730	2,482

*Steel mill products:
- Ingots, blooms, billets, slabs, etc.
- Wire rods
- Structural shapes (plain 3" and over)
- Sheet piling
- Plates
- Rail and track accessories
- Wheels and axles
- Concrete reinforcing bars
- Bar shapes under 3"
- Bars--Hot rolled--Carbon
  - --Alloy
  - --Cold finished (carbon and alloy)
- Hollow drill steel
- Pipe and tubing--Welded
  - --Other
- Round and shaped wire
- Flat wire
- Bale ties
- Galvanized wire fencing
- Wire nails

TABLE IV-4 (continued)

Barbed wire
Black plate
Tin plate
Terne plate
Sheets--Hot rolled
  --Cold rolled
  --Coated (including galvanized)
  --Coated--Alloy
Strip--Hot rolled
  --Cold rolled
  --Hot and cold rolled--Alloy
  --Coated

**Other steel products:
Structural shapes, fabricated
Shapes--Cold formed
Sashes and frames
Fence or sign posts
Wire-Nonmetalic covered
Wire rope
Wire strand
Welded wire fabric
Other nails and staples
Cotton ties and other ties
Bolts, nuts, and rivets
Grinding balls
Blanks, nonrectangular flat rolled
Rigid conduit
Pipe and tube fittings

***Iron products and ferroalloys:
Bar iron, iron slabs and blooms, etc.
Cast iron, soil pipe and fittings
Other cast iron pipe and fittings
Malleable cast iron pipe fittings
Castings and forgings
Pig iron
Sponge iron
Ferromanganese (manganese content)
Ferrosilicon (silicon content)
Ferrochromium (chromium content)
Other ferroalloys
  Total iron products and ferroalloys

Source: American Iron and Steel Institute, Annual Statistical Report (New York: American Iron and Steel Institute, 1969-1953 editions).

mill products, but foreign finished steel and iron products also realized significant growth during this period. Comparison of this growth in imports with the rise in apparent consumption in the domestic market illustrates that that portion of the domestic market which was growing was captured by external producers.

Penetration of the domestic market was particularly high in steel mill (semi-finished) products. Between 1956 and 1967, imports of ingots, billets, and slabs rose from 26 to 220 thousand net tons. In the same 12 year period, imports of wire rods rose from 64 to 1,076 thousand net tons (46 per cent of the domestic wire rod market). Imports of structural shapes and plates rose from 366 to 2,059 thousand net tons and sheets and strip rose from 37 to 3,747 thousand net tons.[20]

The bulk of the imports of steel mill products comes from Europe, Canada, and Japan. In 1956 Europe exported 1,200 thousand net tons; Canada, 59 thousand net tons; and Japan, 48 thousand net tons to the United States. By 1967 this had increased to 5,940 thousand net tons from Europe, 630 thousand net tons from Canada, and 4,468 thousand net tons from Japan. These same three areas also drastically cut back on their needs of United States steel mill products. The exports of steel mill products from the United States changed from 1,629 thousand net tons in 1956 to 350 thousand net tons in 1967 for Canada, from 867 thousand net tons in 1956 to 219 thousand net tons in 1967 for Europe,

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[20] Ibid.

and from 135 thousand net tons in 1956 to 7 thousand net tons in 1967 for Japan.[21]

Tables IV-5 and IV-6 show the exports and imports of the domestic market by areas of destination and origin. As the American industry lost the large markets of Europe, it was also not able to penetrate the markets of the less developed world. Exports of steel to Asia (Japan excluded) rose from 243 thousand net tons in 1955 to a peak of 1,308 thousand net tons in 1964, falling to 716 thousand net tons in 1969. Africa had a net decline in the usage of United States steel mill products during this same period, falling from 122 thousand net tons in 1953 to 96 thousand net tons in 1969.

Oceania (Australia and surrounding islands) and South America decreased their imports of American steel. In 1953 Oceania imported 47 thousand net tons of steel mill products from the United States. By 1969 this had fallen to 18 thousand net tons. South America (including Mexico) decreased its purchases of United States steel mill products from 993 thousand net tons in 1953 to 507 thousand net tons in 1968, although exports to this area increased substantially in 1969.

Table IV-6 summarizes the import situation of steel with respect to the American market. In terms of American imports, Canada, Europe, and Japan began a surge in 1959 that was sustained until 1968 (international agreements reduced imports considerably in 1969). South America has also had considerable success in increasing exports to the

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[21] Ibid.

TABLE IV-5

EXPORTS OF STEEL MILL PRODUCTS BY AREA OF DESTINATION

(Thousands of Net Tons)

Year	Africa	Asia (excluding Japan)	Canada	Europe	Japan	South America (including Mexico)	Oceania
1969	96	716	1,008	2,208	8	1,175	18
1968	112	813	378	330	6	507	23
1967	85	672	350	219	7	331	20
1966	107	483	417	182	6	514	15
1965	99	798	592	401	8	578	20
1964	87	1,308	560	865	10	431	19
1963	75	1,147	940	277	17	333	17
1962	87	940	317	265	59	329	15
1961	60	660	406	313	89	443	18
1960	70	475	580	1,009	74	673	99
1959	12	169	611	213	34	453	7
1958	39	294	1,010	446	56	730	11
1957	92	414	1,619	890	567	1,551	37
1956	84	360	1,629	867	135	1,033	44
1955	114	383	926	1,521	33	819	61
1954	122	259	881	539	22	712	107
1953	122	243	1,111	522	31	993	47

Source: American Iron and Steel Institute, Annual Statistical Report (New York: American Iron and Steel Institute, 1969-1953 editions).

TABLE IV-6

IMPORTS OF STEEL MILL PRODUCTS BY AREA OF ORIGIN

(Thousands of Net Tons)

Year	Africa and Asia (excluding Japan)	South America (including Mexico)	Canada	Europe	Japan	Oceania*
1969	123	332	805	6,418	6,253	104
1968	36	650	1,243	8,735	7,294	154
1967	32	316	630	5,940	4,468	69
1966	62	197	692	4,805	4,851	147
1965	4	159	644	5,130	4,418	29
1964	30	173	692	3,064	2,446	34
1963	120	185	583	2,720	1,808	38
1962	49	50	367	2,450	1,072	114
1961	5	25	304	2,203	597	30
1960	21	50	211	2,402	596	43
1959	46	38	376	3,237	624	69
1958	14		46	1,359	250	35
1957	49		52	997	31	25
1956	30		59	1,200	48	20
1955	n.a.		185	693	96	n.a.
1954	n.a.		25	735	24	5
1953	13		182	1,409	119	n.a.

*1958 and earlier Australia only.

Source: American Iron and Steel Institute, Annual Statistical Report (New York: American Iron and Steel Institute, 1969-1953 editions).

United States. Mexico, which has the most impressive steel industry in South America, supplied 30 per cent of South American exports to the United States in 1967.

The attempts of Africa, Asia, and Oceania to penetrate the American market have been somewhat sporadic. Still, while the relative share of the United States market seems to have declined since the late 1950's, the absolute quantities of imports of basic steel are up from the less developed part of the world.

Tables IV-5 and IV-6 also reflect the decline in United States exports of other steel products--primary fabricated steel products, and iron products and ferroalloys. The decline in these two categories has been about the same as the overall decline in steel mill products. Imports of other steel products and iron products and ferroalloys have also risen considerably, but by a much smaller percentage than have imports of steel mill products. This reflects both the specialized nature of some of the products in these two groups and also the limited scope of these markets.

IV. SUMMARY OF THE FINDINGS

In 1947, world steel production was 148,597 thousand net tons. By 1957 it had increased by 116 per cent to 320,575 thousand net tons and experienced a 323 per cent increase to 628,793 thousand net tons in 1969 (96 per cent over 1957). In contrast, the United States produced only 84,894 thousand net tons in 1947, 112,715 thousand net tons in 1957, and 141,262 thousand net tons in 1969: a less than 70 per cent increase over 1947. While world steel production rose, the United States produced a smaller percentage of it.[22]

This diminuation of the role of the United States steel industry in the world steel economy can be attributed to two trends. First, throughout the world, nations have found steel increasingly easier (from a technological viewpoint) to produce. Consequently, most of the developed nations have dramatically increased production of steel to assist in post-war redevelopment of the manufacturing sectors in their economies. Less developed nations have found it beneficial to the process of industrialization to increase production of steel and to attempt to achieve sufficiency in production. These trends have lowered the need for steel from the United States and change the behavioral context of American industry. The American industry is no longer merely a small group of steel producers. The relevant market has slowly shifted from domestic supply and demand to international supply and demand for steel.

Second, the iron ore input base of the world steel economy has shifted. While total iron ore production increased from 158,000 thousand metric tons in 1953 to 692,508 thousand net tons in 1969, American production has remained stable or decreased.[23] Increased dependency on foreign ore increases uncertainty in the industry, reducing the industrial rationalization achieved through vertical integration.

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[22] Ibid.

[23] Ibid.

CHAPTER V

THE DECLINE OF THE UNITED STATES STEEL INDUSTRY: CONCLUSION

The American steel industry has declined due to fundamental changes in its environment. The problems of this industry can not be attributed merely to the reputed technological backwardness of the industry, to the industry's market structure, or to the problems created by allegedly malign conduct of European and Japanese steel producers.

The displacement of the United States steel industry from its place of dominance in the American industrial structure and from its preeminence in the international market has been a continuous process since the late forties. There is no indication that the introduction of technical changes into the structure of the market or in the basic technology of physical production itself could substantially retard the process of decomposition that has eroded the base of the United States industry. In fact, the industry's adoption of new technology during the 1960's seems to be directly related to the rise of the more serious problems in the industry.

Review of the current literature found that comment on the industry's poor market position was narrowly conceived in terms of identifying the problem with the slow relative speed with which the American industry has adopted the oxygen converter. While certainly an important innovation, arguments established with good justification that the American industry was both a leader and a laggard in adopting new technology. The adoption by the United States of the new oxygen converter took approximately the same average time that it takes inventions to become innovations in most American industries. Relative to the stagnant demand for the product in the domestic market, it is surprising that the industry expanded its new facilities. Considering the necessity of an almost pure iron ore charge for the new oxygen process, the United States industry did not have a low cost input incentive to convert to the new process.

Almost all the discussion ignores the environmental aspects of the market within which steel operates. In general, the mature industry will run into several types of structural difficulties in the operation of its marketplace. There are institutional rigidities, resource inadequacies, and technologically interrelated methods of production. These factors limit the adaptability of an industrial structure facing radical environment changes. Marvin Frankel summarizes the problem of the mature industry.

> As an industry grows and adapts to changing and increasingly complex production methods, interconnections, more or less rigid, develop among its technological components--among machines, plant, transport network and raw material supplies--that make increasingly difficult the introduction into the system of new cost-saving changes. . . . Unable to utilize the new production methods, the industry continues with its old ones. As a result its costs are higher and labor productivity lower than they would be in a less 'mature' industry. The old industry finds itself penalized for having taken the lead. . . .
>
> The existence of interrelatedness need not presuppose a rigid and rudimentary interdependence among a series of machines, and it ought not be regarded as a by-product only of peculiar types of fixed capital. It [technology] extends also to the kinds and

> quality of raw materials, the labor skills, the managerial know-how and the administrative organization necessary to productive activity.[1]

None of the explanations of the ills of the steel industry was complete. The analysis of the industry in terms of the relative competitive and monopolistic elements of its structure and conduct ignored the behavioral context within which the problems of technological interrelatedness must be viewed.

To this end, a behavioral model was developed that related the development of the industry's multiple goals to its historical setting and its present decision making process. Figure II-1, page 69, summarizes the historical structure of the industry. Acting as a small group, the several firms in the industry developed a set of private and public goals. The private goals are centered around promoting stability in and control of the markets for raw materials and for finished steel. The public goals, centering around United States self-sufficiency in steel production and national (military) security, complement the private set and justify state intervention on the behalf of the steel industry.

Commenting on the steel import problem, R. Heath Larry, Executive Vice President of the United States Steel Corporation, wrote in the Wall Street Journal:

> By placing an ever greater reliance upon foreign sources for its most vital metal, the U. S. would be risking both its national

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[1]Marvin Frankel, "Obsolescence and Technological Change in a Maturing Economy," American Economic Review, Vol. 45 (June, 1955), pp. 297, 309.

> security and the basis for a sound and continuing growth of the economy. An adequate, continuing and immediately available source of domestic steel is something the U. S. can not afford to be without.[2]

The author deftly mixes the goal structure to suggest a quota import system be established to save the steel industry from its doldrums.

Figure II-1 indicates that recent market developments have made the context of the historical goal formation process irrelevant. The industry is faced with the problem of adaption to a new industrial structure--one that is basically international in scope.

The objective conditions of steel's malaise are traced in Chapters III and IV. The place of the steel industry in the domestic steel market is examined in Chapter III. The steel industry was found to be growing at a slower rate than the economy over the 1947-1963 period. Steel, as a resource in investment and durable goods, declined over this period. Many of the industries that steel has traditionally supplied had sluggish growth rates. Only a few of steel's buyers performed as well as the economy. Within its market steel producers performed less well than its buyers did. The value of steel supplied to its users declined relative to the value of the production of its users. In a few cases the value of steel used fell absolutely as the value of the production of the buyer expanded. Between 1947 and 1963,

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[2] R. Heath Larry, "A Debate on Steel Protectionism--I," The /New York/ Wall Street Journal, January 8, 1969, p. 10.

every new dollar of demand in the economy had an increasingly smaller impact on the steel industry. Ignoring the impact of imports on the industry, the American industry as a whole was contracting relative to the rest of the economy.

This change in the industrial structure of steel made stability and control increasingly difficult. Interfirm slack was reduced in the contraction, and the standard operating procedures were not adequate to the task of restabilizing the industrial coalition. The public goals of the industry were seriously questioned for substantive content. An affluent service-economy needs steel, but justification of its centrality would be difficult--in fact impossible.

In Chapter IV the impact of foreign steel producers, foreign supplies of raw materials, and foreign steel markets on the United States industry is examined. The first section illustrates the growth of productive capacity and the quest for self-sufficiency in steel in the several nations of the world. The decline of United States steel production relative to world steel production illustrates the fact that the major technological breakthrough in steel in the post-World War II era was not the oxygen converter or continuous casting, but the transfer of existing production methods and techniques to the rest of the world. Even though each nation usually develops its steel industry in a highly paternalistic manner, the decades after 1947 saw a truly international market develop in steel. By itself, this change results in the destruction of the basis of the industrial coalition by broadening its scope beyond control. Now that no one group of steel firms can dominate the market, the increase in the number of firms has eliminated the viability of group decision making.

There has been an attempt to circumvent this new market. The formation of an international cartel, the International Iron and Steel Association, with American, European, and Japanese participation, has been successful in isolating the United States market from further changes in the international steel market. This action has reestablished the viability of the domestic market.[3] The cartel, without explicit government backing, is likely to be a short run phenomenon. Penetration of this lucrative market by less developed countries and reneging by cartel members are probable future events, given the historical record of voluntary cartels.

The iron ore market merely accentuates the changes discussed above. Vertical integration of firms in the domestic market is less important. The stability of the industrial coalition--the maintenance of which is dependent upon control over supply, which vertical integration implies--is eroded by this change in the industrial structure of the market. The growth of South America and Africa as resource sites increases the uncertainty of stable resource supplies. The recent discoveries in Australia will serve to raise the steel potential of Asian producers while continuing to erode the resource base of the American industry.

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[3]Standard and Poor, "The Steel Industry," Industrial Surveys, February 26, 1970; and "Foreign Steelmakers Discussing Setting Voluntary Curbs on Exports to the U. S.," The /New York/ Wall Street Journal, October 22, 1968, p. 5.

The dramatic decline of exports and increase in imports of steel are a result of the changing distribution of world steel production. However, this change affects the stability of the industry very significantly. In his study of the larger manufacturing industries in the United States, Robert T. Averitt noted:

> Several center firms are already so industrially omnifarious that their major concern is for the prosperity of the total economy, for as long as the U. S. economy is strong, they too are strong.[4]

Many industries including steel seem to be composed of center type firms, that is, those firms experiencing long run increasing returns to scale. However, while these highly concentrated markets may gauge their health by that of the economy, long run stability is not necessarily implied by this characteristic. This study chronicled the process by which the steel industry found the security of its former market dissolve in the face of the changing characteristics of both the domestic and international steel economies. Averitt summarized:

> . . . But industrial economies do not hold a fixed form for long. A changing technology provides a slow but continuous metamorphosis in economic structure. Today's key industries may slide down the industrial hierarchy into relative oblivion.
>
> As the rate of technological change increases, the secular decline of all markets is speeded up. New products age quickly and this fact prods the center firm to sharpen its product development and marketing processes. The center economy is, then, a place of feverish activity. Traditional markets face continual challenges from rival center firms and newly developed substitute products.[5]

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[4]Robert T. Averitt, The Dual Economy (New York: W. W. Norton & Co., Inc., 1968), p. 74.

[5]Ibid., p. 75.

The penetration of the economy by large quantities of imported steel eliminated the privileged position that seemed to exist for steel during the 1950's. Control over the industry shifted. The industry lost market control, i.e., industrial slack disappeared. Large steel buyers suddenly commanded significantly more market power than ever before. In the fall of 1969, General Motors threatened the United States Steel Corporation with cancellation of orders if prices continued to rise. While insisting that they would not buy foreign steel, General Motors' bargaining position had been enhanced by the large quantities of foreign steel in the United States.[6]

The overall result of the changes illustrated in Figure II-1, page 69, has been to place the industry in limbo. Its traditional goal structure is irrelevant in today's market. The cartel is an attempt to reestablish the earlier status quo. Meanwhile the industry will continue to grope for new goals if reinforcement of the old ones becomes permanently impossible. There is some indication that the United States steel industry is systematically dismantling itself. The larger firms like United States Steel and Bethlehem are seeking strength and stability through expansion into industrial conglomerates. Several of the other steel firms (Youngstown, Jones and Laughlin, Wheeling, etc.) have disappeared into conglomerate enterprises. Unable to reconstitute the traditional framework of the steel industry, the segments of the

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[6] G. A. Nikolaieff and M. Drapkin, "G. M.'s Supplier-Manufacturer Relationship With U. S. Steel Strained by Price Moves," The /New York/ Wall Street Journal, September 25, 1969, p. 34.

industry are forming new coalitions outside the basic industry definition.

However, the point is that the American steel industry remains in a state of decline. This decline is due, not merely to one form of technological change or one form of market structure (oligopoly), but to the change in the basic institutional and historical framework within which the industry has operated. The decline of the industry should not be met with a hue and cry but as part of the inevitable market process. Viewed from an organic framework, death is certainly as natural as are birth and growth. It was the purpose of this study to demonstrate that the steel industry is in the early stages of a natural decomposition and that this process can be attributed to market forces, not to technological forces.

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APPENDIXES

APPENDIX A

INDUSTRY CLASSIFICATION OF SELECTED INDUSTRIES FOR THE 1947, 1958, AND 1963 INPUT-OUTPUT TABLES

TABLE A-1

INDUSTRY CLASSIFICATION OF SELECTED INDUSTRIES FOR THE 1947, 1958, AND 1963 INPUT-OUTPUT TABLES*

Industry number and title		Related SIC codes (1957 edition)
	11 New construction	
11.01	New construction, residential buildings (nonfarm).	pt. 15, pt. 16, pt. 17, pt. 6561.
11.02	New construction, nonresidential buildings. .	pt.15, pt.17.
11.03	New construction, public utilities	pt.15, pt.16, pt. 17.
11.04	New construction, highways.	pt.16, pt.17.
11.05	New construction, all other	pt.15, pt.16, pt. 17, 138.
	13 Ordnance and accessories	
13.01	Complete guided missiles	1925.
13.02	Ammunition, except for small arms, n.e.c. . .	1929.
13.03	Tanks and tank components	1931.
13.04	Sighting and fire control equipment	1941.
13.05	Small arms	1951.
13.06	Small arms ammunition	1961.
13.07	Other ordnance and accessories	1911,1999.
	20 Lumber and wood products, except containers	
20.01	Logging camps and logging contractors. . . .	2411.
20.02	Sawmills and planing mills, general	2421.
20.03	Hardwood dimensions and flooring.	2426.
20.04	Special product sawmills, n.e.c.	2429.
20.05	Millwork	2431.
20.06	Veneer and plywood	2432.
20.07	Prefabricated wood structures	2433.
20.08	Wood preserving	2491.
20.09	Wood products, n.e.c.	2499.
	23 Other furniture and fixtures	
23.01	Wood office furniture	2521.
23.02	Metal office furniture	2522.
23.03	Public building furniture	2531.
23.04	Wood partitions and fixtures	2541.
23.05	Metal partitions and fixtures	2542.
23.06	Venetian blinds and shades	2591.
23.07	Furniture and fixtures, n.e.c.	2599.
	28 Plastics and synthetic materials	
28.01	Plastics materials and resins	2821.
28.02	Synthetic rubber.	2822.

TABLE A-1 (continued)

28.03	Cellulosic man-made fibers.	2823.
28.04	Organic fibers, noncellulosic	2824.
	35 Glass and glass products	
35.01	Glass and glass products except containers .	3211, 3229, 3231.
35.02	Glass containers.	3221.
	36 Stone and clay products	
36.01	Cement, hydraulic	3241.
36.02	Brick and structural clay tile	3251.
36.03	Ceramic wall and floor tile	3253.
36.04	Clay refractories	3255.
36.05	Structural clay products, n.e.c.	3259.
36.06	Vitreous plumbing fixtures	3261.
36.07	Food utensils, pottery	3262, 3263.
36.08	Porcelain electrical supplies	3264.
36.09	Pottery products, n.e.c.	3269.
36.10	Concrete block and brick	3271.
36.11	Concrete products, n.e.c.	3272.
36.12	Ready-mixed concrete	3273.
36.13	Lime	3274.
36.14	Gypsum products	3275.
36.15	Cut stone and stone products	3281.
36.16	Abrasive products	3291.
36.17	Asbestos products	3292.
36.18	Gaskets and insulations	3293.
36.19	Minerals, ground or treated	3295.
36.20	Mineral wool	3296.
36.21	Nonclay refractories	3297.
36.22	Nonmetallic mineral products, n.e.c.	3299.
	37 Primary iron and steel manufacturing	
37.01	Blast furnaces and basic steel products . . .	331.
37.02	Iron and steel foundries.	332.
37.03	Iron and steel forgings	3391.
37.04	Primary metal products, n.e.c.	3399.
	38 Primary nonferrous metals manufacturing	
38.01	Primary copper	3331.
38.02	Primary lead.	3332.
38.03	Primary zinc	3333.
38.04	Primary aluminum	3334,28195.
38.05	Primary nonferrous metals, n.e.c.	3339.
38.06	Secondary nonferrous metals	3341.
38.07	Copper rolling and drawing	3351.
38.08	Aluminum rolling and drawing	3352.
38.09	Nonferrous rolling and drawing, n.e.c.	3356.
38.10	Nonferrous wire drawing and insulating	3357.

TABLE A-1 (continued)

38.11	Aluminum castings	3361.
38.12	Brass, Bronze and copper castings	3362.
38.13	Nonferrous castings, n.e.c.	3369.
38.14	Nonferrous forgings	3392.
	39 Metal containers	
39.01	Metal cans.	3411.
39.02	Metal barrels, drums and pails	3491.
	40 Heating, plumbing and fabricated structural metal products	
40.01	Metal sanitary ware	3431.
40.02	Plumbing fittings and brass goods	3432.
40.03	Heating equipment, except electric	3433.
40.04	Fabricated structural steel	3441.
40.05	Metal doors, sash and trim	3442.
40.06	Fabricated plate work (boiler shops)	3443.
40.07	Sheet metal work	3444.
40.08	Architectural metal work	3446.
40.09	Miscellaneous metal work	3449.
	41 Screw machine products, bolts, nuts, etc. and metal stampings	
41.01	Screw machine products and bolts, nuts, rivets and washers.	345.
41.02	Metal stampings	3461.
	42 Other fabricated metal products	
42.01	Cutlery	3421.
42.02	Hand and edge tools including saws	3423, 3425.
42.03	Hardware, n.e.c.	3429.
42.04	Coating, engraving and allied services . . .	3471, 3479.
42.05	Miscellaneous fabricated wire products . . .	3481.
42.06	Safes and vaults	3492.
42.07	Steel springs	3493.
42.08	Pipe, valves and pipe fittings	3494, 3498.
42.09	Collapsible tubes	3496.
42.10	Metal foil and leaf	3497.
42.11	Fabricated metal products, n.e.c.	3499.
	43 Engines and turbines	
43.01	Steam engines and turbines	3511.
43.02	Internal combustion engines, n.e.c.	3519.
	44 Farm machinery	
44.00	Farm machinery	3522.
	45 Construction, mining, oil field machinery equipment	
45.01	Construction machinery	3531.

TABLE A-1 (continued)

45.02	Mining machinery	3532.
45.03	Oil field machinery	3533.
	46 Materials handling machinery and equipment	
46.01	Elevators and moving stairways	3534.
46.02	Conveyors and conveying equipment	3535.
46.03	Hoists, cranes and monorails	3536.
46.04	Industrial trucks and tractors	3537.
	47 Metalworking machinery and equipment	
47.01	Machine tools, metal cutting types	3541.
47.02	Machine tools, metal forming types	3542.
47.03	Special dies and tools and machine tool accessories.	3544,3545.
47.04	Metalworking machinery n.e.c.	3548.
	48 Special industry machinery and equipment	
48.01	Food products machinery	3551.
48.02	Textile machinery	3552.
48.03	Woodworking machinery	3553.
48.04	Paper industries machinery	3554.
48.05	Printing trades machinery	3555.
48.06	Special industry machinery, n.e.c.	3559.
	49 General industrial machinery and equipment	
49.01	Pumps and compressors	3561.
49.02	Ball and roller bearings	3562.
49.03	Blowers and fans	3564.
49.04	Industrial patterns	3565.
49.05	Power transmission equipment	3566.
49.06	Industrial furnaces and ovens	3567.
49.07	General industrial machinery, n.e.c.	3569.
	50 Machine shop products	
50.00	Machine shop products	359.
	52 Service industry machines	
52.01	Automatic merchandising machines	3581.
52.02	Commercial laundry equipment	3582.
52.03	Refrigeration machinery	3585.
52.04	Measuring and dispensing pumps	3586.
52.05	Service industry machines, n.e.c.	3589.
	53 Electric transmission and distribution equipment and electrical industrial apparatus	
53.01	Electric measuring instruments	3611.
53.02	Transformers.	3612.
53.03	Switchgear and switchboard apparatus	3613
53.04	Motors and generators	3621.
53.05	Industrial controls	3622.

TABLE A-1 (continued)

53.06	Welding apparatus	3623.
53.07	Carbon and graphite products	3624.
53.08	Electrical industrial apparatus, n.e.c. . . .	3629.
	54 Household appliances	
54.01	Household cooking equipment	3631.
54.02	Household refrigerators and freezers	3632.
54.03	Household laundry equipment	3633.
54.04	Electric housewares and fans	3634.
54.05	Household vacuum cleaners	3635.
54.06	Sewing machines	3636.
54.07	Household appliances, n.e.c.	3639.
	55 Electric lighting and wiring equipment	
55.01	Electric lamps	3641.
55.02	Lighting fixtures	3642.
55.03	Wiring devices	3643, 3644.
	59 Motor vehicles and equipment	
59.01	Truck and bus bodies	3713.
59.02	Truck trailers	3715.
59.03	Motor vehicles and parts	3717.
	60 Aircraft and parts	
60.01	Aircraft	3721.
60.02	Aircraft engines and parts	3722.
60.03	Aircraft propellers and parts	3723.
60.04	Aircraft equipment, n.e.c.	3729.
	61 Other transportation equipment	
61.01	Shipbuilding and repairing	3731.
61.02	Boatbuilding and repairing	3732.
61.03	Locomotives and parts	3741.
61.04	Railroad and street cars	3742.
61.05	Motorcycles, bicycles and parts	3751.
61.06	Trailer coaches	3791.
61.07	Transportation equipment, n.e.c.	3799.

*The titles represent the groupings of industries used for the summary versions of the 1958 and 1963 input-output tables prepared by the Office of Business Economics, United States Department of Commerce. The Office of Business Economics revised the 1947 input-output tables, which originally reflected the 1945 and 1949 Standard Industrial Classification to the sectoring scheme of the 1958 and 1963 tables.

Source: National Economics Division of the Office of Business Economics of the United States Department of Commerce, "Input-Output Structure of the U. S. Economy: 1963," Office of Business Economics, _Survey of Current Business_, Vol. 49 (November, 1969), pp. 16-47.

APPENDIX B

A COMPARISON OF INPUT-OUTPUT TABLES FOR 1947, 1958, AND 1963

TABLE B-1

COMPARISON OF SELECTED INTERINDUSTRY TRANSACTIONS
1947, 1958, 1963

		11[1]	13	23	37
	a[4]	1534	23	0106	4708
	b	2226	62	139	4051
	c	2125	149	181	4897
37[2]	d	692.0000	39.0000	33.0000	-657.0000
	e	0.4511	1.6956	0.3113	-0.1395
	f	591.0000	126.0000	75.0000	189.0000
	g	0.3852	5.4582	0.7075	0.0401
	h	-101.0000	87.0000	42.0000	846.0000
	a	29591	249	1205	21525
	b	52416	4669	1495	19391
	c	65519	6302	1923	24618
Total[3]	d	22825.0000	4420.0000	290.0000	-2134.0000
	e	0.7713	17.7510	0.2406	-0.0991
	f	35928.0000	6053.0000	718.0000	3093.0000
	g	1.2141	24.3092	0.5958	0.1436
	h	13103.0000	1633.0000	428.0000	5227.0000

		39	40	41	42
	a	792	1446	799	710
	b	920	1920	739	1262
	c	993	2154	1047	1543
37	d	128.0000	474.0000	-60.0000	552.0000
	e	0.1616	0.3278	- 0.0750	0.7774
	f	201.0000	708.0000	248.0000	833.0000
	g	0.2537	0.4896	0.3103	1.1732
	h	73.0000	234.0000	308.0000	281.0000
	a	1512	5523	3881	4718
	b	2095	8055	3714	6546
	c	2445	8996	4955	8963
Total	d	583.0000	2532.0000	-167.0000	1828.0000
	e	0.3855	0.4584	-0.0430	0.3874
	f	933.0000	3473.0000	1074.0000	4245.0000
	g	0.6170	0.6288	0.2767	0.8997
	h	350.0000	941.0000	1241.0000	2417.0000

NOTE: See footnotes at the end of the table.

TABLE B-1 (continued)

		43	44	45	46
	a	239	496	513	128
	b	224	367	475	117
	c	235	424	639	170
37	d	-15.0000	-129.0000	-38.0000	-11.0000
	e	-0.0627	-0.2600	-0.0740	-0.0859
	f	-4.0000	-72.0000	126.0000	42.0000
	g	-0.0167	-0.1451	0.2456	0.3281
	h	11.0000	57.0000	164.0000	53.0000
	a	1668	2366	3096	1122
	b	2206	2565	3085	1096
	c	2398	3080	4062	1617
Total	d	538.0000	199.0000	-11.0000	-26.0000
	e	0.3225	0.0841	-0.0035	-0.0231
	f	730.0000	714.0000	966.0000	495.0000
	g	0.4376	0.3017	0.3120	0.4411
	h	192.0000	515.0000	977.0000	521.0000

		47	48	49	50
	a	270	329	382	85
	b	277	244	400	127
	c	443	337	594	196
37	d	7.0000	-85.0000	18.0000	42.0000
	e	0.0259	-0.2583	0.0471	0.4941
	f	173.0000	8.0000	212.0000	111.0000
	g	0.6407	0.0243	0.5549	1.3058
	h	166.0000	93.0000	194.0000	69.0000
	a	3404	3317	3412	703
	b	3666	2541	3753	1604
	c	5144	3716	5354	2257
Total	d	262.0000	-776.0000	341.0000	901.0000
	e	0.0769	-0.2339	0.0999	1.2816
	f	1740.0000	399.0000	1942.0000	1554.0000
	g	0.5111	0.1202	0.5691	2.2105
	h	1478.0000	1175.0000	1601.0000	653.0000

TABLE B-1 (continued)

		52	53	54	55
	a	161	384	327	116
	b	154	296	275	155
	c	212	386	342	201
37	d	-7.0000	-88.0000	-52.0000	39.0000
	e	-0.0434	-0.2291	-0.1590	0.3362
	f	51.0000	2.0000	15.0000	85.0000
	g	0.3167	0.0052	0.0458	0.7327
	h	58.0000	90.0000	67.0000	46.0000
	a	1637	4026	2833	1898
	b	2254	5160	3595	2298
	c	3391	6495	4673	3081
Total	d	617.0000	1134.0000	762.0000	400.0000
	e	0.3769	0.2816	0.2689	0.2107
	f	1754.0000	2469.0000	1840.0000	1183.0000
	g	1.0714	0.6132	0.6494	0.6232
	h	1137.0000	1335.0000	1078.0000	783.0000

		59	60	61	GNP[5]
	a	2155	165	578	
	b	2005	405	442	
	c	3453	315	615	
37	d	-150.0000	240.0000	-136.0000	
	e	-0.0696	1.4545	-0.2352	
	f	1298.0000	150.0000	37.0000	
	g	0.6023	0.9090	0.0640	
	h	1448.0000	-90.0000	173.0000	
	a	19036	2498	4077	314112
	b	23469	12751	3782	447344
	c	40031	14317	4894	590389
Total	d	4433.0000	10253.0000	-295.0000	133232.0000
	e	0.2328	4.1044	-0.0723	0.4241
	f	20995.0000	11819.0000	817.0000	276277.0000
	g	1.1029	4.7313	0.2003	0.8795
	h	16562.0000	1566.0000	1112.0000	143045.0000

TABLE B-1 (continued)

[1]Each column shows the value of each industry's input of steel (row 37) and the total value in dollars of each industry's output. Each year, 1947, 1958, and 1963, is presented and the differences are compared. For titles see Table A-1, Appendix A, page 164.

[2]This row displays the distribution of steel to each of the selected industries and the final users of the output of steel in terms of dollar value.

[3]This row illustrates the dollar value of the output of each of the selected industries in each column.

[4](a) The dollar value of transactions for 1947 in terms of 1958 prices (in millions of dollars).

(b) The dollar value of transactions for 1958 in terms of 1958 prices (in millions of dollars).

(c) The dollar value of transactions for 1963 in terms of 1963 prices (in millions of dollars).

(d) The dollar value difference of transactions between 1947 and 1958 (in millions of dollars). $d = b - a$

(e) The percentage change in the value of transactions between 1947 and 1958. $e = \frac{d}{a}$

(f) The dollar value difference of transactions between 1947 and 1963 (in millions of dollars). $f = c - a$

(g) The percentage change in the value of transactions between 1947 and 1963. $g = \frac{f}{a}$

(h) The dollar value difference of transactions between 1958 and 1963 (in millions of dollars). $h = c - b$

[5]Gross national product for 1947, 1958, and 1963.

Source: The table was developed from data in the United States Department of Commerce Input-Output Tables. Office of Business Economics of the United States Department of Commerce, The Input-Output Structure of the United States Economy: 1947 (Washington: Government Printing Office, 1970); National Economics Division of the Office of Business Economics of the United States Department of Commerce, "The Transactions Table of the 1958 Input-Output Study and Revised Direct and Total Requirements Data," Survey of Current Business, Vol. 45 (September, 1965), pp. 33-49; and National Economics Division of the Office of Business Economics of the United States Department of Commerce, "Input-Output Structure of the U. S. Economy: 1963," Survey of Current Business, Vol. 49 (November, 1969), pp. 16-47.

TABLE B-2

COMPARISON OF DIRECT REQUIREMENTS PER DOLLAR OF GROSS OUTPUT
FOR SELECTED INDUSTRIES IN 1947, 1958, AND 1963

		11[1]	13	23	37	39	40	41	42
	a[2]	0.07953	0.00563	0.07613	0.00131	0.00114	0.00763	0.00213	0.00937
	b	0.06258	0.00024	0.05947	0.00102	0.00041	0.00235	0.00509	0.00799
	c	0.05424	0.00253	0.07783	0.00140	0.00085	0.00238	0.00727	0.00637
20	d	-0.01695	-0.00539	-0.01666	-0.00029	-0.00073	-0.00528	0.00296	-0.00138
	e	-0.21312	-0.95737	-0.21883	-0.22137	-0.64035	-0.69200	1.38967	-0.14727
	f	-0.02529	-0.00310	0.00170	0.00009	-0.00029	-0.00525	0.00514	-0.00300
	g	-0.31799	-0.55062	0.02233	0.06870	-0.25438	-0.68807	2.41314	-0.32017
	h	-0.00834	0.00229	0.01836	0.00038	0.00044	0.00003	0.00218	-0.00162
	a	0.00030	-------	0.00197	-------	-------	0.00005	0.00081	0.00060
	b	-------	-------	0.00111	0.00024	0.00097	0.00032	0.00399	0.00093
	c	0.00002	0.00015	-------	0.00001	0.00104	-------	0.00484	0.00001
28	d	-------	-------	-0.00086	-------	-------	0.00027	0.00318	0.00033
	e	-------	-------	-0.43654	-------	-------	5.40000	3.92592	0.55000
	f	-0.00028	-------	-------	-------	-------	-------	0.00403	-0.00059
	g	-0.93333	-------	-------	-------	-------	-------	4.97530	-0.98333
	h	-------	-------	-------	0.00023	0.00007	-------	0.00085	-0.00092
	a	0.00035	-------	0.01095	-------	0.00143	0.00323	0.00045	0.00021
	b	0.00163	0.00091	0.03723	0.00006	0.00002	0.00372	0.00101	0.00025
	c	0.00123	-------	0.02104	-------	-------	0.00818	0.00030	0.00108
35	d	0.00128	-------	0.02628	-------	-0.00141	0.00049	0.00056	0.00004
	e	3.65714	-------	2.40000	-------	-0.98601	0.15170	1.24444	0.19047
	f	0.00088	-------	0.01009	-------	-------	0.00495	-0.00015	0.00087
	g	2.51428	-------	0.92146	-------	-------	1.53250	-0.33333	4.14285
	h	-0.00040	-------	-0.01619	-------	-------	0.00446	-0.00071	0.00083

NOTE: See footnotes at the end of the table.

TABLE B-2 (continued)

		11	13	23	37	39	40	41	42
	a	0.06790	0.00094	0.00116	0.01157	0.00127	0.00375	0.00768	0.00513
	b	0.07793	0.00272	0.00172	0.01540	0.00197	0.00621	0.00773	0.00697
	c	0.08872	-------	0.00787	0.00185	0.00204	0.00233	0.00380	0.00804
36	d	0.01003	0.00178	0.00056	0.00383	0.00070	0.00246	0.00005	0.00184
	e	0.14771	1.89361	0.48275	0.33102	0.55118	0.65600	0.00651	0.35867
	f	0.02082	-------	0.00671	-0.00972	0.00077	-0.00142	-0.00388	0.00291
	g	0.30662	-------	5.78448	-0.84010	0.60629	-0.37866	-0.50520	0.56725
	h	0.01079	-------	0.00615	-0.01355	0.00007	-0.00388	0.00393	0.00107
	a	0.05184	0.09066	0.08833	0.22980	0.52375	0.26181	0.20596	0.15049
	b	0.04246	0.01321	0.09310	0.22710	0.43903	0.23837	0.19912	0.19275
	c	0.03244	0.02350	0.09426	0.19890	0.40606	0.23940	0.21134	0.17215
37	d	-0.00938	-0.07745	0.00477	-0.00270	-0.08472	-0.02344	-0.00684	0.04226
	e	-0.18094	-0.85429	0.05400	-0.01174	-0.16175	-0.08953	-0.03321	0.28081
	f	-0.01940	-0.06716	0.00593	-0.03090	-0.11769	-0.02241	0.00538	0.02166
	g	-0.37422	-0.74078	0.06713	-0.13446	-0.22470	-0.08559	0.02612	0.14392
	h	-0.01002	0.01029	0.00116	-0.02820	-0.03297	0.00103	0.01222	-0.02060
	a	0.02651	0.08237	0.01070	0.03541	0.01308	0.04438	0.04693	0.06954
	b	0.01658	0.04822	0.01325	0.01646	0.00957	0.07282	0.06477	0.06675
	c	0.01898	0.03066	0.01023	0.02145	0.01437	0.07462	0.05782	0.08275
38	d	-0.00993	-0.03415	0.00255	-0.01895	-0.00351	0.02844	0.01784	-0.00278
	e	-0.37457	-0.41459	0.23831	-0.53515	-0.26834	0.64082	0.38014	-0.03997
	f	-0.00753	-0.05171	-0.00047	-0.01396	0.00129	0.03024	0.01089	0.01321
	g	-0.28404	-0.62777	-0.04392	-0.39423	0.09862	0.68138	0.23204	0.18996
	h	0.00240	-0.01756	-0.00302	0.00499	0.00480	0.00180	-0.00695	0.01599

TABLE B-2 (continued)

		43	44	45	46	47	48	49	50
	a	0.00174	0.00504	0.00193	0.00212	0.00160	0.00643	0.00200	0.00058
	b	0.00027	0.00351	0.00124	0.00076	0.00138	0.00553	0.00143	-------
	c	0.00076	0.00243	0.00083	0.00059	0.00110	0.00405	0.00174	0.00075
20	d	-0.00147	-0.00153	-0.00069	-0.00136	-0.00022	-0.00090	-0.00057	-------
	e	-0.84482	-0.30357	-0.35751	-0.64150	-0.13750	-0.13996	-0.28500	-------
	f	-0.00098	-0.00261	-0.00110	-0.00153	-0.00050	-0.00238	-0.00026	0.00017
	g	-0.56321	-0.51785	-0.56994	-0.72169	-0.31250	-0.37013	-0.13000	0.29310
	h	0.00049	-0.00108	-0.00041	-0.00017	-0.00028	-0.00148	0.00031	-------
	a	0.00013	0.00002	-------	0.00003	0.00004	0.00023	0.00108	-------
	b	0.00065	0.00015	0.00047	0.00048	0.00043	0.00072	0.00027	-------
	c	-------	-------	-------	-------	0.00036	0.00126	0.00001	-------
28	d	0.00052	0.00013	-------	0.00045	0.00039	0.00049	-0.00081	-------
	e	4.00000	6.50000	-------	15.00000	9.75000	2.13043	-0.75000	-------
	f	-------	-------	-------	-------	0.00002	0.00103	-0.00107	-------
	g	-------	-------	-------	-------	0.50000	4.47826	-0.99074	-------
	h	-------	-------	-------	-------	-0.00037	0.00054	-0.00026	-------
	a	0.00097	0.00035	0.00338	0.00005	0.00007	0.00056	0.00005	0.00111
	b	0.00053	0.00011	0.00003	0.00030	0.00014	0.00005	0.00005	0.00005
	c	-------	-------	-------	-------	0.00005	0.00035	-------	0.00008
35	d	-0.00044	-0.00024	0.00335	0.00025	0.00007	-0.00051	0.00000	-0.00106
	e	-0.45360	-0.68571	0.99112	5.00000	1.00000	-0.91071	0.00000	-0.95495
	f	-------	-------	-------	-------	-0.00002	-0.00021	-------	-0.00103
	g	-------	-------	-------	-------	-0.28571	-0.37500	-------	-0.92792
	h	-------	-------	-------	-------	-0.00009	0.00030	-------	0.00003

TABLE B-2 (continued)

		43	44	45	46	47	48	49	50
	a	0.00846	0.00202	0.00288	0.00199	0.00521	0.00228	0.00514	0.00135
	b	0.00651	0.00540	0.00578	0.00374	0.00730	0.00431	0.00919	0.01725
	c	0.00749	0.00301	0.00334	0.00102	0.01631	0.00258	0.00855	0.01208
36	d	-0.00195	0.00338	0.00290	0.00175	0.00209	0.00203	0.00405	0.01590
	e	-0.23049	1.67326	1.00694	0.87939	0.40115	0.89035	0.78793	11.77777
	f	-0.00097	0.00099	0.00046	-0.00097	0.01110	0.00030	0.00341	0.01073
	g	-0.11465	0.49009	0.15972	-0.48743	2.13051	0.13157	0.66342	7.94814
	h	0.00098	-0.00239	-0.00244	-0.00272	0.00901	-0.00173	-0.00064	-0.00517
	a	0.14345	0.20986	0.16601	0.11405	0.07943	0.09928	0.11213	0.12019
	b	0.10147	0.14289	0.15395	0.10716	0.07549	0.08821	0.10647	0.07914
	c	0.09811	0.13781	0.15722	0.10490	0.08607	0.09071	0.11089	0.08670
37	d	-0.04198	-0.06697	-0.01206	-0.00689	-0.00394	-0.01107	-0.00566	-0.04105
	e	-0.29264	-0.31911	-0.07264	-0.06041	-0.04960	-0.11150	-0.05047	-0.34154
	f	-0.04534	-0.07205	-0.00879	-0.00915	0.00664	-0.00857	-0.00124	-0.03349
	g	-0.31606	-0.34332	-0.05294	-0.08022	0.08359	-0.08632	-0.01105	-0.27864
	h	-0.00336	-0.00508	0.00327	-0.00226	0.01058	0.00250	0.00442	0.00756
	a	0.02289	0.00846	0.00584	0.00797	0.01194	0.02170	0.03258	0.06833
	b	0.03278	0.00745	0.00715	0.01153	0.02902	0.04426	0.02822	0.07672
	c	0.03829	0.00719	0.01126	0.01557	0.02545	0.02557	0.03532	0.04059
38	d	0.00989	-0.00101	0.00131	0.00356	0.01708	0.02256	-0.00436	0.00839
	e	0.43206	-0.11938	0.22431	0.44667	1.43048	1.03963	-0.13382	0.12278
	f	0.01540	-0.00127	0.00542	0.00760	0.01351	0.00387	0.00274	-0.02774
	g	0.67278	-0.15011	0.92808	0.95357	1.13149	0.17834	0.08410	-0.40597
	h	0.00551	-0.00026	0.00411	0.00404	-0.00357	-0.01869	0.00710	-0.03613

TABLE B-2 (continued)

		52	53	54	55	59	60	61
	a	0.00564	0.00221	0.00478	0.00360	0.00210	0.00220	0.01092
	b	0.00326	0.00126	0.00159	0.00123	0.00054	0.00170	0.02396
	c	0.00199	0.00086	0.00226	0.00088	0.00067	0.00200	0.03089
20	d	-0.00238	-0.00095	-0.00319	-0.00237	-0.00156	-0.00050	0.01304
	e	-0.42198	-0.42986	-0.66736	-0.65833	-0.74285	-0.22727	1.19413
	f	-0.00365	-0.00135	-0.00252	-0.00272	-0.00143	-0.00020	0.01997
	g	-0.64716	-0.61085	-0.52719	-0.75555	-0.68095	-0.09090	1.82875
	h	-0.00127	-0.00040	0.00067	-0.00035	0.00013	0.00030	0.00693
	a	0.00036	0.00547	0.00260	0.00635	0.00248	0.00088	0.00186
	b	0.00100	0.00683	0.00259	0.01856	0.00112	0.00067	0.00716
	c	-------	0.00317	0.00430	0.00958	0.00028	0.00126	0.00270
28	d	0.00064	0.00136	-0.00001	0.01221	-0.00136	-0.00021	0.00530
	e	1.77777	0.24862	-0.00384	1.92283	-0.54838	-0.23863	2.84946
	f	-------	-0.00230	0.00170	0.00323	-0.00220	0.00038	0.00084
	g	-------	-0.42047	0.65384	0.50866	-0.88709	0.43181	0.45161
	h	-------	-0.00366	0.00171	-0.00898	-0.00084	0.00059	-0.00446
	a	0.00410	0.00136	0.00193	0.04600	0.00778	0.00003	0.00207
	b	0.00276	0.00088	0.00183	0.02885	0.01001	0.00013	0.00503
	c	-0.00120	0.00086	0.00281	0.03577	0.00915	0.00008	0.00402
35	d	-0.00134	-0.00048	-0.00010	-0.01715	0.00223	0.00010	0.00296
	e	-0.32682	-0.35294	-0.05181	-0.37262	0.28663	3.33333	1.42995
	f	-0.00290	-0.00050	0.00088	-0.01023	0.00137	0.00005	0.00195
	g	-0.70731	-0.36764	0.45595	-0.22239	0.17609	1.66666	0.94202
	h	-0.00156	-0.00002	0.00098	0.00692	-0.00086	-0.00005	-0.00101

TABLE B-2 (continued)

		52	53	54	55	59	60	61
	a	0.00672	0.01776	0.01056	0.00508	0.00394	0.00256	0.00294
	b	0.00593	0.00776	0.00779	0.00666	0.00271	0.00374	0.00813
	c	0.00664	0.00902	0.01161	0.01045	0.00198	0.00252	0.00401
36	d	-0.00079	-0.01000	-0.00277	0.00158	-0.00123	0.00118	0.00519
	e	-0.11755	-0.56306	-0.26231	0.31102	-0.31218	0.46093	1.76530
	f	-0.00008	-0.00874	0.00105	0.00537	-0.00196	-0.00004	0.00107
	g	-0.01190	-0.49211	0.09943	1.05708	-0.49746	-0.01562	0.36394
	h	0.00071	0.00126	0.00382	0.00379	-0.00073	-0.00122	-0.00412
	a	0.11084	0.09546	0.11552	0.06096	0.11323	0.06613	0.14176
	b	0.06834	0.05731	0.07644	0.06742	0.08543	0.03179	0.11697
	c	0.06264	0.05948	0.07336	0.06516	0.08627	0.02204	0.12569
37	d	-0.04250	-0.03815	-0.03908	0.00646	-0.02780	-0.03434	-0.02479
	e	-0.38343	-0.39964	-0.33829	0.10597	-0.24551	-0.51928	-0.17487
	f	-0.04820	-0.03598	-0.04216	0.00420	-0.02696	-0.04409	-0.01607
	g	-0.43486	-0.37691	-0.36495	0.06889	-0.23809	-0.66671	-0.11336
	h	-0.00570	0.00217	-0.00308	-0.00226	0.00084	-0.00975	0.00872
	a	0.03944	0.06566	0.05320	0.05052	0.01966	0.03972	0.01219
	b	0.05072	0.07156	0.04249	0.05161	0.01113	0.02822	0.01809
	c	0.04353	0.06426	0.04278	0.07831	0.01366	0.04046	0.02549
38	d	0.01128	0.00590	-0.01071	0.00109	-0.00853	-0.01150	0.00590
	e	0.28600	0.06985	-0.20131	0.02157	-0.43387	-0.28952	0.48400
	f	0.00409	-0.00140	-0.01042	0.02779	-0.00600	0.00074	0.01330
	g	0.10370	-0.02132	-0.19586	0.55007	-0.30518	0.01863	1.09105
	h	-0.00719	-0.00730	0.00029	0.02670	0.00253	0.01224	0.00740

TABLE B-2 (continued)

[1]Each column shows the inputs that the industry numbered at the top of that column required from each of the industries numbered at the beginning of the rows to produce a dollar of its output for 1947, 1958, and 1963. A comparison of each year's direct requirements coefficient follows. For industry titles, see Table A-1, Appendix A, page 164.

[2](a) The 1947 direct requirements coefficient: the value in cents of the row input per dollar of the column out put in 1947 in terms of 1958 prices.

(b) The 1958 direct requirements coefficient: the value in cents of the row input per dollar of the column output in 1958 in terms of 1958 prices.

(c) The 1963 direct requirements coefficient: the value in cents of the row input per dollar of the column output in 1963 in terms of 1963 prices.

(d) The value in cents of the difference between the 1947 and the 1958 direct requirements coefficients. $d = b - a$

(e) The percentage change in the direct requirements coefficients between 1947 and 1958. $e = \frac{d}{a}$

(f) The value in cents of the difference between the 1947 and the 1963 direct requirements coefficients. $f = c - a$

(g) The percentage change in the direct requirements coefficients between 1947 and 1963. $g = \frac{f}{a}$

(h) The value in cents of the difference between the 1958 and the 1963 direct requirements coefficients. $h = c - b$

Source: The table was developed from data in the United States Department of Commerce Input-Output Tables. Office of Business Economics of the United States Department of Commerce, The Input-Output Structure of the United States Economy: 1947 (Washington: Government Printing Office, 1970); National Economics Division of the Office of Business Economics of the United States Department of Commerce, "The Transactions Table of the 1958 Input-Output Study and Revised Direct and Total Requirements Data," Survey of Current Business, Vol. 45 (September, 1965), pp. 33-49; and National Economics Division of the Office of Business Economics of the United States Department of Commerce, "Input-Output Structure of the U. S. Economy: 1963," Survey of Current Business, Vol. 49 (November, 1969), pp. 16-47.

TABLE 8-3

COMPARISON OF TOTAL REQUIREMENTS (DIRECT AND INDIRECT) PER DOLLAR OF DELIVERY TO FINAL DEMAND FOR SELECTED INDUSTRIES IN 1947, 1958, AND 1963

		11[1]	13	23	37	39	40	41	42
	a[2]	0.10604	0.01663	0.10816	0.00738	0.00926	0.01896	0.01124	0.01852
	b	0.09396	0.00558	0.09636	0.00606	0.00612	0.00914	0.01249	0.01666
	c	0.08342	0.00789	0.12357	0.00592	0.00692	0.00976	0.01568	0.01538
20	d	-0.01208	-0.01105	-0.01180	-0.00132	-0.00314	-0.00982	0.00125	-0.00186
	e	-0.11391	-0.66446	-0.10909	-0.17386	-0.33909	-0.51793	0.11120	-0.10043
	f	-0.02262	-0.00874	0.01541	-0.00146	-0.00234	-0.00920	0.00444	-0.00314
	g	-0.21331	-0.52555	0.14247	-0.19783	-0.25269	-0.48523	0.39501	-0.16954
	h	-0.01054	0.00231	0.02721	-0.00014	0.00080	0.00062	0.00319	-0.00128
	a	0.00315	0.00279	0.00843	0.00125	0.00314	0.00281	0.00323	0.00310
	b	0.00740	0.00984	0.01398	0.00419	0.00906	0.00585	0.01090	0.00740
	c	0.00744	0.00861	0.02019	0.00305	0.00817	0.00593	0.01245	0.00966
28	d	0.00425	0.00705	0.00555	0.00294	0.00592	0.00304	0.00767	0.00430
	e	1.34920	2.52688	0.65836	2.35200	1.88535	1.08185	2.37461	1.38709
	f	0.00429	0.00582	0.01176	0.00180	0.00503	0.00312	0.00922	0.00656
	g	1.36190	2.08602	1.39501	1.44000	1.60191	1.11032	2.85448	2.11612
	h	0.00004	-0.00123	0.00621	-0.00114	-0.00089	0.00008	0.00155	0.00226
	a	0.00631	0.00100	0.01373	0.00068	0.00255	0.00497	0.00202	0.00144
	b	0.00407	0.00341	0.04169	0.00093	0.00103	0.00528	0.00263	0.00147
	c	0.00380	0.00258	0.02453	0.00059	0.00065	0.00987	0.00149	0.00219
35	d	-0.00224	0.00241	0.02796	0.00025	-0.00152	0.00031	0.00061	0.00003
	e	-0.35499	2.41000	2.03641	0.36764	-0.59607	0.06237	0.30198	0.02063
	f	-0.00251	0.00158	0.01080	-0.00009	-0.00190	0.00490	-0.00053	0.00075
	g	-0.39778	1.58000	0.78659	-0.13235	-0.74509	0.98591	-0.26237	0.52083
	h	-0.00027	-0.00083	-0.01716	-0.00034	-0.00038	0.00459	-0.00114	0.00072

NOTE: See footnotes at the end of the table.

TABLE B-3 (continued)

		11	13	23	37	39	40	41	42
	a	0.07922	0.00555	0.00678	0.01899	0.01373	0.01398	0.01619	0.01241
	b	0.09584	0.01124	0.00939	0.02635	0.01586	0.01764	0.01797	0.01686
	c	0.10439	0.00412	0.01362	0.00531	0.00565	0.00704	0.00777	0.01299
36	d	0.01662	0.00569	0.00261	0.00736	0.00213	0.00366	0.00178	0.00447
	e	0.20979	1.02522	0.38495	0.38757	0.15513	0.26180	0.10994	0.36019
	f	0.02517	-0.00143	0.00684	-0.01368	-0.00808	-0.00694	-0.00842	0.00058
	g	0.31772	-0.25765	1.00884	-0.72037	-0.58849	-0.49642	-0.52007	0.04673
	h	0.00855	-0.00712	0.00423	-0.02104	-0.01021	-0.01060	-0.01020	-0.00389
	a	0.12844	0.13995	0.15315	1.31923	0.72578	0.41499	0.33594	0.25662
	b	0.11089	0.07045	0.15406	1.31825	0.59711	0.35657	0.30328	0.29192
	c	0.09410	0.06616	0.15212	1.29070	0.53772	0.35032	0.30520	0.25527
37	d	-0.01755	-0.06950	0.00091	-0.00098	-0.12867	-0.05842	-0.03266	0.03530
	e	-0.13663	-0.49660	0.00594	-0.00074	-0.17728	-0.14077	-0.09721	0.13755
	f	-0.03434	-0.07379	-0.00103	-0.02853	-0.18806	-0.06467	-0.03074	-0.00135
	g	-0.26736	-0.52725	-0.00672	-0.02162	-0.25911	-0.15583	-0.09150	-0.00526
	h	-0.01679	-0.00429	-0.00194	-0.02755	-0.05939	-0.00625	0.00192	-0.03665
	a	0 05826	0.12606	0.03481	0.06912	0.06313	0.10253	0.09736	0.12323
	b	0.04934	0.11322	0.03760	0.04207	0.03920	0.13334	0.11780	0.12018
	c	0.05693	0.09180	0.03742	0.05295	0.04955	0.14896	0.11403	0.15414
38	d	-0.00892	-0.01284	0.00279	-0.02705	-0.02393	0.03081	0.02044	-0.00305
	e	-0.15310	-0.10185	0.08014	-0.39134	-0.37905	0.30049	0.20994	-0.02475
	f	-0.00133	-0.03426	0.00261	-0.01617	-0.01358	0.04643	0.01667	0.03091
	g	-0.02282	-0.27177	0.07497	-0.23394	-0.21511	0.45284	0.17122	0.25083
	h	0.00759	-0.02142	-0.00018	0.01088	0.01035	0.01562	-0.00377	0.03396

TABLE 8-3 (continued)

		43	44	45	46	47	48	49	50
	a	0.00905	0.01356	0.00819	0.00816	0.00621	0.01370	0.00861	0.00645
	b	0.00452	0.00933	0.00572	0.00624	0.00539	0.01225	0.00647	0.00307
	c	0.00625	0.00892	0.00593	0.00565	0.00570	0.01041	+0.00705	0.00522
20	d	-0.00453	-0.00423	-0.00247	-0.00192	-0.00082	-0.00145	-0.00214	-0.00338
	e	-0.50055	-0.31194	-0.30158	-0.23529	-0.13204	-0.10583	-0.24854	-0.52403
	f	-0.00280	-0.00464	-0.00226	-0.00251	-0.00051	-0.00329	-0.00156	-0.00123
	g	-0.30939	-0.34218	-0.27594	-0.30759	-0.08212	-0.24014	-0.18118	-0.19069
	h	0.00173	-0.00041	0.00021	-0.00059	0.00031	-0.00184	0.00058	+0.00215
	a	0.00289	0.00478	0.00308	0.00315	0.00206	0.00328	0.00387	0.00178
	b	0.00636	0.01008	0.00681	0.00948	0.00509	0.00750	0.00543	0.00422
	c	0.00510	0.00853	0.00807	0.01067	0.00576	0.00817	0.00532	0.00460
28	d	0.00347	0.00530	0.00373	0.00633	0.00303	0.00422	0.00156	0.00244
	e	1.20069	1.10878	1.21103	2.00952	1.47087	1.28658	0.40310	1.37078
	f	0.00221	0.00375	0.00499	0.00752	0.00370	0.00489	0.00145	0.00282
	g	0.76470	0.78451	1.62012	2.38730	1.79611	1.49085	0.37467	1.58426
	h	-0.00126	-0.00155	0.00126	0.00119	0.00067	0.00067	-0.00011	0.00038
	a	0.00240	0.00177	0.00489	0.00149	0.00097	0.00176	0.00141	0.00198
	b	0.00209	0.00163	0.00138	0.00204	0.00179	0.00149	0.00143	0.00090
	c	0.00126	0.00133	0.00127	0.00162	0.00109	0.00167	0.00136	0.00119
35	d	-0.00031	-0.00014	-0.00351	0.00055	0.00082	-0.00027	0.00002	-0.00108
	e	-0.12916	-0.07909	-0.71779	0.35912	0.84536	-0.15340	0.01418	-0.54545
	f	-0.00114	-0.00044	-0.00362	0.00013	0.00012	-0.00009	-0.00005	-0.00079
	g	-0.47500	-0.24858	-0.74028	0.08724	0.12371	-0.05113	-0.03546	-0.39898
	h	-0.00083	-0.00030	-0.00011	-0.00042	-0.00070	0.00018	-0.00007	0.00029

TABLE B-3 (continued)

		43	44	45	46	47	48	49	50
	a	0.01765	0.01140	0.01125	0.00955	0.01076	0.00869	0.01255	0.00730
	b	0.01655	0.01549	0.01574	0.01362	0.01520	0.01268	0.01902	0.02722
	c	0.01418	0.00901	0.00911	0.00684	0.02346	0.00779	0.01455	0.01885
36	d	-0.00110	0.00409	0.00449	0.00407	0.00444	0.00399	0.00647	0.01992
	e	-0.06232	0.35877	0.39911	0.42617	0.41263	0.45914	0.51553	2.72876
	f	-0.00347	-0.00239	-0.00214	-0.00271	0.01270	-0.00090	0.00200	0.01155
	g	-0.19660	-0.20964	-0.19022	-0.28376	1.18029	-0.10356	0.15936	1.58219
	h	-0.00237	-0.00648	-0.00663	-0.00678	0.00826	-0.00489	-0.00447	-0.00637
	a	0.28170	0.36543	0.29759	0.22818	0.15581	0.19159	0.21738	0.20794
	b	0.19905	0.24739	0.26426	0.21354	0.15091	0.16897	0.19609	0.14101
	c	0.19074	0.24653	0.26954	0.21050	0.16067	0.17473	0.19841	0.15387
37	d	-0.08265	-0.11804	-0.03333	-0.01464	-0.00490	-0.02262	-0.02129	-0.06693
	e	-0.29339	-0.32301	-0.11199	-0.06415	-0.03144	-0.11806	-0.09793	-0.32187
	f	-0.09096	-0.11890	-0.02805	-0.01768	0.00484	-0.01686	-0.01897	-0.05407
	g	-0.32289	-0.32537	-0.09425	-0.07748	0.03105	-0.08800	-0.08726	-0.26002
	h	-0.00831	-0.00086	0.00528	-0.00304	0.00974	0.00576	0.00232	0.01286
	a	0.06920	0.04939	0.04285	0.04518	0.03871	0.05775	0.07622	0.11937
	b	0.08104	0.04027	0.03730	0.05229	0.06767	0.09388	0.07274	0.13600
	c	0.10065	0.04930	0.05306	0.06369	0.06886	0.07257	0.08914	0.09204
38	d	0.01184	-0.00912	-0.00555	0.00711	0.02896	0.03613	-0.00348	0.01663
	e	0.17109	-0.18465	-0.12952	0.15737	0.74812	0.62562	-0.04565	0.13931
	f	0.03165	-0.00009	0.01021	0.01851	0.03015	0.01482	0.01292	-0.02733
	g	0.45736	-0.00182	0.23827	0.40969	0.77886	0.25662	0.16950	-0.22895
	h	0.01981	0.00903	0.01576	0.01140	0.00119	-0.02131	0.01640	-0.04396

TABLE 8-3 (continued)

		52	53	54	55	59	60	61
	a	0.01813	0.00998	0.01991	0.01242	0.01027	0.00932	0.02213
	b	0.01377	0.00633	0.01110	0.00732	0.00651	0.00628	0.04160
	c	-0.01104	0.00665	0.01100	0.00776	0.00663	0.00437	0.05432
20	d	-0.00436	-0.00365	-0.00881	-0.00510	-0.00376	-0.00304	0.01947
	e	-0.24048	-0.36573	-0.44249	-0.41062	-0.36611	-0.32618	0.87980
	f	-0.00709	-0.00333	-0.00691	-0.00466	-0.00364	-0.00495	0.03219
	g	-0.39106	-0.33365	-0.44751	-0.37520	-0.35443	-0.53111	1.45458
	h	-0.00273	0.00032	-0.00010	0.00044	0.00012	-0.00191	0.01272
	a	0.00543	0.00976	0.00818	0.01045	0.01089	0.00386	0.00524
	b	0.01046	0.01436	0.01478	0.02832	0.01552	0.00652	0.01558
	c	0.01281	0.01218	0.02287	0.02229	0.01459	0.00738	0.01283
28	d	0.00503	0.00460	0.00660	0.01787	0.00463	0.00266	0.01034
	e	0.92633	0.47131	0.80684	1.71004	0.42516	0.68911	1.97328
	f	0.00738	0.00242	0.01469	0.01184	0.00370	0.00352	0.00759
	g	1.35911	0.24795	1.79584	1.13301	0.33976	0.91191	1.44847
	h	0.00235	-0.00218	0.00809	-0.00603	-0.00093	0.00086	-0.00275
	a	0.00636	0.00404	0.00472	0.05285	0.01245	0.00143	0.00418
	b	0.00524	0.00373	0.00390	0.03291	0.01656	0.00211	0.00764
	c	0.00378	-0.00347	0.00517	0.04105	0.01608	0.00193	0.00639
35	d	-0.00112	-0.00031	-0.00082	-0.01994	0.00411	0.00068	0.00346
	e	-0.17610	-0.07673	-0.17372	-0.37729	0.33012	0.47552	0.82775
	f	-0.00258	-0.00057	0.00045	-0.01180	0.00363	0.00050	0.00221
	g	-0.40566	-0.14108	0.09533	-0.22327	0.29156	0.34965	0.52870
	h	-0.00146	-0.00026	0.00127	0.00814	-0.00048	-0.00018	-0.00125

TABLE B-3 (continued)

		52	53	54	55	59	60	61
	a	0.01746	0.02659	0.02208	0.01431	0.01370	0.00817	0.01108
	b	0.01580	0.01522	0.01653	0.01475	0.01260	0.01065	0.01841
	c	0.01457	0.01497	0.01903	0.01727	0.00833	0.00716	0.00989
36	d	-0.00166	-0.01137	-0.00555	0.00044	-0.00110	0.00248	0.00733
	e	-0.09507	-0.42760	-0.25135	0.03074	-0.08029	0.30354	0.66155
	f	-0.00289	-0.01162	-0.00305	0.00296	-0.00537	-0.00101	-0.00119
	g	-0.16552	-0.43700	-0.13813	0.20684	-0.39197	-0.12362	-0.10740
	h	-0.00123	-0.00025	0.00250	0.00252	-0.00427	-0.00349	-0.00852
	a	0.24318	0.17653	0.25399	0.14441	0.26245	0.26245	0.26919
	b	0.15950	0.11059	0.15596	0.12175	0.20265	0.08595	0.21941
	c	0.16181	0.11776	0.15410	0.12107	0.21208	0.06801	0.23114
37	d	-0.08368	-0.06594	-0.09803	-0.02266	-0.05980	-0.17650	-0.04978
	e	-0.34410	-0.37353	-0.38596	-0.15691	-0.22785	-0.67250	-0.18492
	f	-0.08137	-0.05877	-0.09989	-0.02334	-0.05037	-0.19444	-0.03805
	g	-0.33460	-0.33291	-0.39328	-0.16162	-0.19192	-0.74068	-0.14134
	h	0.00231	0.00717	-0.00186	-0.00068	0.00943	-0.01794	0.01173
	a	0.10076	0.12046	0.12149	0.10341	0.06981	0.08313	0.05255
	b	0.11683	0.12932	0.09436	0.10073	0.05101	0.07624	0.05795
	c	0.12247	0.13221	0.10903	0.15345	0.06478	0.09819	0.07868
38	d	0.01607	0.00886	-0.02713	-0.00268	-0.01880	-0.00689	0.00540
	e	0.15948	0.07355	-0.22331	-0.02591	-0.26930	-0.08288	0.10275
	f	0.02171	0.01175	-0.01246	0.05004	-0.00503	0.01506	0.02613
	g	0.21546	0.09754	-0.10255	0.48389	-0.07205	0.18116	0.49724
	h	0.00564	0.00289	0.01467	0.05272	0.01377	0.02195	0.02073

TABLE B-3 (continued)

[1]Each column shows the output required directly and indirectly from the industry numbered at the beginning of each row for each dollar of deliveries to final demand by the industry numbered at the head of the column for 1947, 1958, and 1963. A comparison of each year's total requirements coefficient follows. For industry titles, see Table A-1, Appendix A, page 164.

[2](a) The 1947 total requirements coefficient: the value in cents of required production in the row industry per dollar of delivery to final demand by the column industry in 1947 in terms of 1958 prices.

(b) The 1958 total requirements coefficient: the value in cents of required production in the row industry per dollar of delivery to final demand by the column industry in 1958 in terms of 1958 prices.

(c) The 1963 total requirements coefficient: the value in cents of required production in the row industry per dollar of delivery to final demand by the column industry in 1963 in terms of 1963 prices.

(d) The value in cents of the difference between the 1947 and the 1958 total requirements coefficients. $d = b - a$

(e) The percentage change in the total requirements coefficients between 1947 and 1958. $e = \frac{d}{a}$

(f) The value in cents of the difference between the 1947 and the 1963 total requirements coefficients. $f = c - a$

(g) The percentage change in the total requirements coefficients between 1947 and 1963. $g = \frac{f}{a}$

(h) The value in cents of the difference between the 1958 and the 1963 total requirements coefficients. $h = c - b$

Source: The table was developed from data in the United States Department of Commerce Input-Output Tables. Office of Business Economics of the United States Department of Commerce. _The Input-Output Structure of the United States Economy: 1947_ (Washington: Government Printing Office, 1970); National Economics Division of the Office of Business Economics of the United States Department of Commerce, "The Transactions Table of the 1958 Input-Output Study and Revised Direct and Total Requirements Data," _Survey of Current Business_, Vol. 45 (September, 1965), pp. 33-49; and National Economics Division of the Office of Business Economics of the United States Department of Commerce, "Input-Output Structure of the U. S. Economy: 1963," _Survey of Current Business_, Vol. 49 (November, 1969), pp. 16-47.

APPENDIX C

STEEL SUFFICIENCY--AN INTERNATIONAL COMPARISON OF THE CONSUMPTION AND PRODUCTION OF CRUDE STEEL

TABLE C-1

STEEL SUFFICIENCY--CONSUMPTION AND PRODUCTION
OF CRUDE STEEL: 1949-1967

(Thousands of Metric Tons of Crude Steel)

	UNITED STATES			ADVANCED NATIONS AUSTRIA		
Year	Consumption[1]	Production[2]	Sufficiency Coefficient[3]	Consumption	Production	Sufficiency Coefficient
1967	126,187	115,406	.915	1,904	3,023	1.588
1966	131,314	121,654	.926	2,065	3,193	1.546
1965	127,684	119,260	.934	2,078	3,221	1.550
1964	118,067	115,281	.976	1,957	3,194	1.632
1963	102,309	99,120	.969	1,692	2,947	1.750
1962	91,058	89,202	.980	1,684	2,970	1.764
1961	89,694	88,917	.991	1,888	3,101	1.643
1960	90,497	90,067	.995	1,897	3,163	1.667
1959	87,180	84,773	.972	1,387	2,512	1.811
1958	75,529	77,342	1.024	1,418	2,393	1.688
1957	97,178	102,253	1.052	1,444	2,509	1.738
1956	100,910	104,522	1.036	1,432	2.078	1.451
1955	102,456	106,173	1.036	1,271	1,823	1.434
1954	77,663	80,115	1.031	1,092	1,653	1.514
1953	99,640	101,250	1.016	878	1,283	1.461
1952	81,337	84,520	1.039	994	1,058	1.064
1951	94,346	45,435	1.012	887	1,028	1.158
1950	85,951	87,848	1.022	792	947	1.196
1949	66,010	70,740	1.072	721	835	1.158

NOTE: See footnotes at the end of the table.

TABLE C-1 (continued)

	ADVANCED NATIONS					
	BELGIUM--LUXEMBOURG			CANADA		
Year	Consumption	Production	Sufficiency Coefficient	Consumption	Production	Sufficiency Coefficient
1967	4,180	15,197	3.636	9,088	8,794	.968
1966	3,110	13,307	4.279	9,802	9,074	.926
1965	3,230	13,754	4.258	10,415	9,098	.874
1964	4,065	13,290	3.269	8,553	8,283	.968
1963	3,347	11,660	3.484	7,143	7,430	1.040
1962	2,987	11,372	3.807	6,419	6,417	1.000
1961	3,257	11,115	3.413	5,881	5,886	.959
1960	2,604	11,272	4.329	5,494	5,270	.959
1959	2,643	10,100	3.821	6,187	5,354	.865
1958	2,318	9,392	4.052	5,386	3,955	.734
1957	2,929	10,769	3.676	6,689	4,598	.687
1956	2,733	10,838	3.965	6,420	4,809	.749
1955	2,683	9,077	3.383	5,021	4,114	.819
1954	2,611	7,801	2.988	4,159	2,898	.697
1953	2,224	7,156	3.218	5,155	3,734	.724
1952	2,396	8,069	3.368	5,125	3,359	.655
1951	2,252	8,131	3.611	5,112	3,237	.633
1950	2,221	6,228	2.804	4,188	3,070	.733
1949	1,834	6,115	3.334	4,002	2,892	.723

TABLE C-1 (continued)

Year	CZECHOSLOVAKIA Consumption	Production	Sufficiency Coefficient	DENMARK Consumption	Production	Sufficiency Coefficient
1967	8,337	10,002	1.200	1,583	401	.253
1966	7,758	9,128	1.177	1,540	405	.263
1965	7,423	8,599	1.158	1,719	412	.240
1964	7,005	8,377	1.196	1,580	396	.251
1963	6,788	7,600	1.120	1,202	359	.299
1962	7,105	7,639	1.074	1,261	367	.291
1961	6,791	7,043	1.037	1,233	323	.262
1960	6,501	6,768	1.041	1,185	317	.268
1959	5,935	6,136	1.034	1,078	292	.302
1958	5,102	5,509	1.080	844	255	.302
1957	4,814	5,166	1.073	912	262	.287
1956	4,214	4,882	1.159	813	240	.295
1955	--	4,474	--	814	237	.291
1954	--	4,270	--	735	199	.271
1953	--	4,366	--	624	180	.288
1952	--	3,754	--	596	176	.295
1951	--	3,455	--	683	161	.236
1950	--	3,122	--	647	123	.190
1949	--	--	--	575	76	.132

TABLE C-1 (continued)

Year	FINLAND Consumption	FINLAND Production	FINLAND Sufficiency Coefficient	FRANCE[4] Consumption	FRANCE[4] Production	FRANCE[4] Sufficiency Coefficient
1967	1,257	394	.313	17,941	19,655	1.096
1966	1,227	347	.283	17,143	19,585	1.142
1965	1,210	363	.302	16,171	19,604	1.212
1964	1,170	371	.317	17,234	19,780	1.147
1963	1,014	326	.321	15,602	17,557	1.125
1962	1,043	304	.291	14,923	17,240	1.155
1961	1,100	277	.252	14,167	17,570	1.240
1960	1,022	254	.246	13,919	17,281	1.242
1959	830	232	.280	11,511	15,218	1.317
1958	595	186	.313	14,486	14,616	1.009
1957	923	204	.221	13,590	14,096	1.039
1956	739	194	.263	12,319	13,398	1.087
1955	706	177	.251	10,397	12,592	1.211
1954	665	175	.263	9,337	10,627	1.138
1953	379	147	.388	8,700	9,997	1.149
1952	652	147	.225	10,616	10,867	1.024
1951	581	127	.219	7,993	9,835	1.230
1950	420	102	.243	6,670	8,625	1.293
1949	444	111	.250	--	--	--

TABLE C-1 (continued)

Year	FEDERAL REPUBLIC OF GERMANY Consumption	Production	Sufficiency Coefficient	ITALY Consumption	Production	Sufficiency Coefficient
1967	28,523	36,744	1.288	16,322	15,890	.974
1966	30,492	35,316	1.158	14,175	13,639	.962
1965	31,886	36,821	1.155	12,101	12,681	1.048
1964	33,734	37,339	1.107	11,269	9,793	.896
1963	27,276	31,597	1.158	13,971	10,157	.727
1962	27,804	32,563	1.171	11,938	9,757	.817
1961	27,571	33,458	1.214	10,901	9,124	.837
1960	29,211	34,100	1.167	9,226	8,229	.892
1959	24,216	29,435	1.216	7,016	6,762	.964
1958	20,136	26,270	1.305	6,250	6,271	1.003
1957	21,097	27,973	1.326	6,733	6,787	1.008
1956	21,520	26,563	1.234	5,794	5,908	1.020
1955	21,397	24,501	1.145	5,660	5,395	.953
1954	16,522	20,268	1.227	4,826	4,207	.872
1953	14,601	18,103	1.240	4,109	3,500	.852
1952	14,640	18,631	1.273	3,987	3,535	.887
1951	11,011	16,109	1.463	3,514	3,063	.872
1950	10,147	14,019	1.382	2,936	2,362	.805
1949	8,563	9,156	1.067	2,243	2,055	.916

TABLE C-1 (continued)

Year	JAPAN Consumption	JAPAN Production	JAPAN Sufficiency Coefficient	THE NETHERLANDS Consumption	THE NETHERLANDS Production	THE NETHERLANDS Sufficiency Coefficient
1967	51,221	62,154	1.213	4,721	2,407	.827
1966	36,449	47,784	1.311	3,959	3,268	.825
1965	28,841	41,161	1.427	3,848	3,138	.816
1964	31,417	39,799	1.267	3,962	2,646	.678
1963	24,726	31,501	1.274	3,140	2,342	.746
1962	22,945	27,546	1.200	3,132	2,087	.666
1961	25,763	28,268	1.097	3,180	1,971	.620
1960	19,476	22,138	1.136	3,186	1,942	.610
1959	15,103	16,629	1.101	2,701	1,670	.618
1958	10,278	12,118	1.179	2,324	1,438	.619
1957	12,627	12,570	.995	2,876	1,185	.412
1956	9,956	11,106	1.115	2,580	1,050	.407
1955	7,282	9,408	1.292	2,522	980	.389
1954	6,413	7,750	1.208	2,210	934	.423
1953	6,730	7,662	1.138	2,045	867	.424
1952	5,023	6,988	1.391	1,800	685	.381
1951	5,302	6,502	1.226	1,841	554	.300
1950	4,157	4,839	1.164	1,664	490	.294
1949	2,766	3,111	1.125	1,491	428	.287

TABLE C-1 (continued)

Year	NORWAY Consumption	NORWAY Production	NORWAY Sufficiency Coefficient	POLAND Consumption	POLAND Production	POLAND Sufficiency Coefficient
1967	1,413	790	.559	10,011	10,450	1.044
1966	1,415	715	.505	9,508	9,850	1.036
1965	1,359	676	.497	8,528	9,088	1.066
1964	1,170	614	.525	7,963	8,573	1.077
1963	1,024	542	.529	7,432	8,004	1.077
1962	1,092	488	.447	7,197	7,684	1.068
1961	1,049	499	.476	6,931	7,234	1.044
1960	987	490	.496	6,282	6,681	1.064
1959	888	426	.480	5,694	6,160	1.082
1958	806	371	.460	5,451	5,663	1.039
1957	907	350	.386	4,932	5,304	1.075
1956	974	291	.299	4,645	5,014	1.079
1955	854	171	.200	4,309	4,426	1.027
1954	680	121	.178	--	3,949	--
1953	615	111	.180	--	3,604	--
1952	584	98	.168	--	3,179	--
1951	581	88	.151	--	2,787	--
1950	467	81	.173	--	2,515	--
1949	642	77	.120	--	--	--

TABLE C-1 (continued)

Year	SWEDEN Consumption	Production	Sufficiency Coefficient	U.S.S.R. Consumption	Production	Sufficiency Coefficient
1967	4,633	4,768	1.029	97,738	102,224	1.046
1966	5,058	4,764	.942	92,289	96,900	1.050
1965	5,272	4,725	.896	86,604	91,021	1.051
1964	4,771	4,444	.931	80,849	85,038	1.052
1963	4,143	3,899	.941	77,347	80,231	1.037
1962	4,005	3,614	.902	73,981	76,307	1.031
1961	4,087	3,560	.871	68,382	70,756	1.035
1960	4,077	3,218	.789	63,513	65,294	1.028
1959	3,380	2,862	.848	58,070	59,972	1.033
1958	2,897	2,413	.833	53,344	54,920	1.030
1957	3,096	2,510	.811	49,337	51,176	1.037
1956	2,817	2,425	.861	47,043	48,698	1.035
1955	2,921	2,150	.736	--	45,271	--
1954	2,553	1,861	.729	--	41,434	--
1953	2,299	1,782	.775	--	38,128	--
1952	2,513	1,688	.672	--	34,492	--
1951	2,278	1,525	.669	--	31,350	--
1950	2,054	1,456	.709	--	27,329	--
1949	2,137	1,371	.642	--	--	--

TABLE C-1 (continued)

Year	UNITED KINGDOM Consumption	UNITED KINGDOM Production	UNITED KINGDOM Sufficiency Coefficient	HUNGARY Consumption	HUNGARY Production	HUNGARY Sufficiency Coefficient
1967	21,389	24,278	1.135	2,637	2,739	1.039
1966	21,247	24,705	1.163	2,377	2,649	1.114
1965	23,131	27,439	1.186	2,234	2,520	1.128
1964	23,747	26,651	1.122	2,266	2,365	1.044
1963	19,899	22,882	1.450	2,259	2,374	1.051
1962	17,731	20,820	1.174	2,237	2,333	1.043
1961	18,838	22,440	1.191	2,168	2,053	.947
1960	22,243	24,695	1.110	2,088	1,887	.904
1959	17,284	20,510	1.187	1,726	1,759	1.019
1958	17,326	19,880	1.147	1,585	1,627	1.026
1957	19,116	22,047	1.153	1,514	1,375	.908
1956	19,470	20,990	1.078	--	1,415	--
1955	18,684	20,108	1.076	--	1,629	--
1954	16,430	18,817	1.145	--	1,491	--
1953	16,302	17,891	1.097	--	1,543	--
1952	16,606	16,681	1.005	--	1,459	--
1951	13,933	15,889	1.146	--	1,290	--
1950	14,045	16,554	1.179	--	1,048	--
1949	14,602	15,803	1.082	--	--	--

TABLE C-1 (continued)

Year	LESS DEVELOPED NATIONS					
	ARGENTINA			AUSTRALIA		
	Consumption	Production	Sufficiency Coefficient	Consumption	Production	Sufficiency Coefficient
1967	2,029	1,325	.653	5,269	6,288	1.193
1966	1,909	1,281	.671	5,508	5,890	1.069
1965	2,538	1,370	.540	5,842	5,459	.934
1964	2,045	1,267	.620	4,778	5,047	1.056
1963	1,354	913	.674	4,245	4,653	1.096
1962	1,546	644	.417	3,572	4,238	1.186
1961	2,379	442	.186	3,996	3,947	.938
1960	1,585	277	.175	4,070	3,753	.922
1959	1,996	214	.107	3,087	3,450	1.118
1958	2,051	244	.119	2,437	3,183	1.306
1957	1,409	221	.157	3,125	2,819	.902
1956	1,427	202	.142	3,003	2,357	.785
1955	2,086	218	.105	3,064	2,244	.732
1954	1,572	186	.118	2,722	2,178	.800
1953	637	174	.273	2,109	1,858	.881
1952	859	126	.147	2,201	1,576	.716
1951	1,470	132	.090	2,412	1,497	.621
1950	1,124	130	.116	2,249	1,263	.562
1949	1,113	--	--	1,680	1,183	.704

TABLE C-1 (continued)

Year	BRAZIL Consumption	Production[6]	Sufficiency Coefficient	CHILE Consumption	Production[7]	Sufficiency Coefficient
1967	4,005	3,696	.923	676	596	.886
1966	4,092	3,580	.875	630	540	.857
1965	3,139	2,896	.923	602	441	.733
1964	3,417	2,939	.860	625	544	.870
1963	3,393	2,737	.807	628	489	.779
1962	2,852	2,396	.840	630	495	.786
1961	2,701	1,995	.739	506	363	.717
1960	2,668	1,843	.691	531	422	.795
1959	2,400	1,608	.670	441	415	.941
1958	1,924	1,362	.708	490	348	.710
1957	1,876	1,299	.692	498	388	.779
1956	1,543	1,375	.841	387	381	.984
1955	1,494	1,162	.778	354	290	.819
1954	1,835	1,148	.626	302	321	1.063
1953	1,238	1,016	.821	261	373	1.429
1952	1,241	893	.720	255	243	.953
1951	1,228	843	.686	239	178	.745
1950	1,038	769	.741	143	56	.391
1949	840	609	.725	205	32	.156

TABLE C-1 (continued)

Year	CHINA[a]			TAIWAN (CHINA)		
	Consumption	Production	Sufficiency Coefficient	Consumption	Production	Sufficiency Coefficient
1967	16,105	11,000	.683	895	443	.495
1966	13,595	16,000	1.177	798	326	.409
1965	10,949	15,000	1.370	626	260	.415
1964	9,990	14,000	1.400	483	236	.489
1963	12,299	12,000	.976	397	215	.542
1962	12,240	10,000	.817	330	182	.552
1961	18,289	9,500	.519	287	185	.645
1960	19,205	18,450	.961	289	200	.692
1959	14,197	13,350	.940	225	159	.707
1958	8,000	11,080	1.385	169	107	.633
1957	5,544	5,350	.965	105	89	.848
1956	5,325	4,465	.838	135	79	.585
1955	3,479	2,853	.820	138	40	.290
1954	2,765	2,225	.805	122	25	.205
1953	--	1,774	--	--	20	--
1952	--	1,349	--	--	18	--
1951	--	900	--	--	16	--
1950	--	600	--	--	14	--

TABLE C-1 (continued)

	COLUMBIA			GREECE		
Year	Consumption	Production	Sufficiency Coefficient	Consumption	Production	Sufficiency Coefficient
1967	409	207	.506	832	160	.192
1966	514	174	.339	839	210	.250
1965	431	204	.473	722	210	.292
1964	543	200	.368	718	210	.292
1963	465	200	.430	666	209	.314
1962	358	194	.504	525	155	.295
1961	405	181	.447	405	140	.346
1960	387	157	.406	410	125	.305
1959	256	109	.426	276	90	.326
1958	148	121	.811	300	113	.377
1957	275	117	.426	271	--	--
1956	389	90	.231	225	--	--
1955	335	77	.230	212	--	--
1954	293	--	--	180	--	--
1953	299	--	--	170	--	--
1952	156	--	--	209	--	--
1951	141	--	--	--	--	--
1950	161	--	--	--	--	--

TABLE C-1 (continued)

Year	INDIA Consumption	INDIA Production[7]	INDIA Sufficiency Coefficient	ISRAEL Consumption	ISRAEL Production	ISRAEL Sufficiency Coefficient
1967	6,405	6,380	.996	316	--	--
1966	6,844	6,606	.965	397	84	.175
1965	7,519	6,316	.840	480	84	.175
1964	7,435	6,032	.811	538	83	.154
1963	7,280	5,970	.820	450	83	.184
1962	6,437	5,149	.800	395	80	.203
1961	5,154	4,084	.792	313	62	.198
1960	4,643	3,286	.708	359	40	.111
1959	3,525	2,473	.702	298	24	.081
1958	3,637	1,842	.506	261	--	--
1957	3,619	1,742	.481	263	--	--
1956	3,591	1,766	.492	295	--	--
1955	2,800	1,732	.619	261	--	--
1954	2,244	1,712	.763	312	--	--
1953	1,874	1,531	.817	177	--	--
1952	1,849	1,603	.867	182	--	--
1951	1,724	1,524	.884	111	--	--
1950	1,756	1,461	.832	237	--	--
1949	1,842	1,374	.746	--	--	--

TABLE C-1 (continued)

	MEXICO			PERU		
Year	Consumption	Production[7]	Sufficiency Coefficient	Consumption	Production	Sufficiency Coefficient
1967	3,285	3,060	.932	313	62	.198
1966	2,955	2,721	.921	396	80	.202
1965	2,731	2,399	.878	399	81	.203
1964	2,579	2,280	.884	276	75	.272
1963	2,167	1,974	.911	259	73	.282
1962	1,890	1,851	.979	249	73	.293
1961	1,840	1,725	.938	246	76	.309
1960	1,735	1,500	.865	171	60	.351
1959	1,241	1,213	.977	95	51	.537
1958	1,329	988	.743	149	20	.134
1957	1,351	687	.509	179	--	--
1956	1,317	591	.449	174	--	--
1955	1,029	510	.496	146	--	--
1954	808	454	.562	90	--	--
1953	751	462	.615	135	--	--
1952	912	601	.659	93	--	--
1951	953	453	.475	100	--	--
1950	707	337	.477	86	--	--
1949	582	345	.593	82	--	--

TABLE C-1 (continued)

	PORTUGAL			SOUTHERN RHODESIA[9]		
Year	Consumption	Production	Sufficiency Coefficient	Consumption	Production	Sufficiency Coefficient
1967	654	316	.483	151	--	--
1966	695	269	.387	308	130	.422
1965	679	274	.404	255	130	.570
1964	542	250	.461	256	128	.500
1963	532	222	.417	202	84	.416
1962	434	175	.403	211	88	.417
1961	539	68	.126	244	92	.377
1960	393	--	--	251	86	.343
1959	368	--	--	247	46	.186
1958	366	--	--	215	60	.279
1957	392	--	--	238	67	.282
1956	308	--	--	256	58	.227
1955	283	--	--	202	52	.257
1954	273	--	--	192	33	.172
1953	235	--	--	175	25	.143
1952	171	--	--	190	36	.189
1951	--	--	--	--	28	--
1950	--	--	--	--	23	--

TABLE C-1 (continued)

Year	RUMANIA Consumption	RUMANIA Production	RUMANIA Sufficiency Coefficient	REPUBLIC OF SOUTH AFRICA Consumption	REPUBLIC OF SOUTH AFRICA Production[7]	REPUBLIC OF SOUTH AFRICA Sufficiency Coefficient
1967	--	4,088	--	3,881	3,651	.941
1966	4,084	3,670	.899	3,355	3,285	.979
1965	3,918	3,426	.874	4,207	3,293	.783
1964	4,053	3,039	.750	3,399	3,107	.914
1963	3,098	2,704	.872	2,681	2,834	1.057
1962	3,104	2,451	.790	2,376	2,634	1.109
1961	3,174	2,126	.669	2,380	2,475	1.040
1960	2,827	1,086	.639	2,164	2,113	.976
1959	2,269	1,420	.629	1,471	1,895	.961
1958	1,670	934	.559	2,312	1,832	.792
1957	1,524	864	.567	2,222	1,737	.782
1956	1,442	779	.540	1,928	1,605	.832
1955	--	766	--	1,904	1,580	.830
1954	--	628	--	1,660	1,431	.862
1953	--	717	--	1,689	1,298	.769
1952	--	698	--	1,736	1,258	.725
1951	--	644	--	1,516	1,007	.664
1950	--	555	--	1,250	816	.653
1949	--	--	--	1,334	636	.477

TABLE C-1 (continued)

	SPAIN			TURKEY		
Year	Consumption	Production	Sufficiency Coefficient	Consumption	Production	Sufficiency Coefficient
1967	6,035	6,720	.718	777	996	1.282
1966	6,720	3,750	.558	1,013	842	.831
1965	6,142	3,516	.572	857	581	.678
1964	3,426	3,150	.919	819	405	.495
1963	3,105	2,492	.803	817	331	.405
1962	2,809	2,311	.823	560	242	.432
1961	2,260	2,340	1.035	549	282	.514
1960	1,817	1,919	1.050	602	266	.442
1959	2,082	1,823	.875	479	214	.447
1958	1,820	1,560	.857	275	160	.582
1957	1,614	1,346	.834	298	176	.591
1956	1,498	1,243	.830	384	193	.503
1955	1,458	1,213	.832	464	188	.405
1954	1,250	1,100	.880	360	169	.469
1953	995	897	.906	545	163	.299
1952	956	904	.946	381	153	.402
1951	--	818	--	280	135	.482
1950	--	815	--	307	91	.296
1949	--	729	--	194	100	.515

TABLE C-1 (continued)

	UNITED ARAB REPUBLIC			URUGUAY		
Year	Consumption	Production	Sufficiency Coefficient	Consumption	Production	Sufficiency Coefficient
1967	745	--	--	30	14	.467
1966	809	195	.241	49	10	.204
1965	779	179	.230	64	13	.203
1964	680	177	.260	84	14	.167
1963	439	194	.442	67	7	.104
1962	474	188	.397	106	9	.085
1961	373	156	.418	86	9	.105
1960	326	136	.417	124	10	.081
1959	217	112	.516	149	--	--
1958	243	28	.115	159	--	--
1957	218	--	--	141	--	--
1956	231	--	--	120	--	--
1955	406	--	--	103	--	--
1954	324	--	--	165	--	--
1953	186	--	--	116	--	--
1952	159	--	--	72	--	--
1951	256	--	--	140	--	--
1950	372	--	--	136	--	--

TABLE C-1 (continued)

Year	VENEZUELA Consumption	VENEZUELA Production	VENEZUELA Sufficiency Coefficient	REPUBLIC OF KOREA Consumption	REPUBLIC OF KOREA Production	REPUBLIC OF KOREA Sufficiency Coefficient
1967	1,200	690	.575	744	320	.430
1966	1,101	537	.487	635	216	.340
1965	1,200	625	.521	419	192	.458
1964	1,000	441	.441	279	129	.462
1963	797	364	.453	418	160	.383
1962	600	225	.375	--	149	--
1961	448	75	.167	--	66	--
1960	510	47	.092	--	50	--
1959	684	50	.073	--	38	--
1958	799	--	--			
1957	1,556	--	--			
1956	858	--	--			
1955	671	--	--			
1954	499	--	--			
1953	444	--	--			
1952	502	--	--			
1951	465	--	--			
1950	226	--	--			
1949	461	--	--			

TABLE C-1 (continued)

	NORTH KOREA		
Year	Consumption	Production	Sufficiency Coefficient
1967	1,365	1,450	1.062
1966	1,308	1,300	.994
1965	1,255	1,230	.980
1964	1,158	1,132	.978
1963	1,047	1,022	.976
1962	--	1,050	--
1961	--	766	--
1960	--	641	--
1959	--	451	--

[1]Consumption: The data relates to apparent consumption of crude steel (i.e., production plus imports minus exports) and they do not take into consideration changes in stocks. The external trade data employed for steel products cover ingots and semis--, all rolled products, steel tubes and fastenings, steel wires, railway tires, wheels, and sales--group 681 in the United Nations Standard International Trade Classification. The crude steel totals were computed on the following basis. Crude steel equivalent of one metric ton of: ingots and semis = 1.12; flat products = 1.35; other rolled products = 1.20; tube and wire = 1.30. Unfortunately, this formula is little used in conversion of other series for finished steel to cruda steel equivalents, due primarily to the list of equivalency lack of explicitness.

[2]Production: the data are crude steel production levels of the domestic industry.

TABLE C-1 (continued)

[3]The Sufficiency Coefficient: the sufficiency coefficient is the proportion of national consumption that is domestically produced in each year. A sufficiency coefficient of one is an indication that the nation is basically self-sufficient in steel.

[4]1950-1959 includes the SAAR.

[5]Beginning July, 1959, includes the SAAR.

[6]Excluding alloy steels.

[7]Ingots only (India before 1963, Mexico before 1959, Republic of South Africa before 1965).

[8]Source: estimation by the United States Bureau of Mines.

[9]Prior to 1965, the Federation of Rhodesia and Nyasaland.

Source: United Nations, Statistical Yearbook (New York: Statistical Office of the United Nations, Department of Economic and Social Affairs, 1951, 1954, 1958, 1962, 1965, 1968 editions).