ABSTRACT

INTRAINDUSTRY STRUCTURE, INTEGRATION STRATEGIES, AND PETROLEUM FIRM PERFORMANCE

by

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This study investigates the extent to which the profitability of firms that operate in multiple markets is determined by the structure within industries as well as industrywide elements of market structure. Building upon a body of literature in the field of industrial organization which relaxes the conventional structure-performance assumption of intraindustry homogeneity, the analysis suggests that within an industry differences in firms' competitive strategies amount to variations in the elements of industrial structure. It is posited that two key competitive strategies which determine firm profitability are vertical and conglomerate integration and that integrated firms may possess market power even if the horizontal structural conditions within individual markets are not consonant with those that are generally thought to confer such power. The central thesis is that profitability models which omit elements of multimarket structure underestimate the true magnitude of barriers to new competition and the recognition of mutual dependence among competitors. Using econometric techniques the fit of additive and interactive variants of a basic model developed to explain the dispersion of profit rates among firms within an industry is tested on a cross-section sample of U. S. firms from the petroleum refining industry for the 1970-1973 period. The
results indicate that apart from their horizontal market positions, firms which are extensively integrated tend to earn systematically higher rates of return than their less-integrated counterparts within the industry. Moreover, it was found that profitability is enhanced when firms' patterns of integration are parallel, i.e., when firms meet simultaneously across several integrated markets. In conjunction with evidence on the extent of technical efficiency associated with vertical and conglomerate integration in petroleum, the findings suggest that antitrust policy should focus on ways to reduce, though not eliminate, both integration and horizontal dominance of petroleum firms.
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by

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CHAPTER I

INTRODUCTION: INTRAIINDUSTRY STRUCTURE, INTEGRATION STRATEGIES, AND FIRM PERFORMANCE

I.A. Introduction

This study investigates the extent to which the performance (profits) of firms that operate in multiple markets is determined by the structure within industries as well as industrywide elements of market structure. It is based on the proposition that the assumption of intraindustry homogeneity, common to conventional structure-performance analyses of industrial organization, limits both the development and scope of such analyses. After advancing hypotheses that relate corporate strategies of integration and other elements of industry structure to economic performance, I develop and test a model to see how these factors explain the dispersion of profit rates among firms within the petroleum industry.

The analysis embraces and builds upon a small but growing body of literature in the field of industrial organization which suggests that, within an industry, differences in firms' competitive strategies amount to variations in the elements of industrial structure that determine performance.¹ The framework that I employ to explain

¹. The most complete statement of this hypothesis can be found in Michael E. Porter, "The Structure Within Industries and Companies' Performance," Review of Economics and Statistics 61 (May 1979): 214-27.
Intraindustry differences in firm profitability posits that an industry is composed of a set(s) of firms that pursue common competitive strategies and, thus, are likely to respond in similar ways to disturbances; each set of firms constitutes a "strategic group." Firms' movements between strategic groups are constrained by "mobility barriers" induced by the standard sources of barriers to new competition (e.g., economies of scale, product differentiation, excessive capital requirements, absolute cost advantages, and proprietary knowledge), but are strategic group-specific (rather than industry-specific) by nature. Those strategic groups that possess high barriers to mobility have greater protection from intraindustry rivalry by virtue of their position within the configuration of strategic groups, have superior bargaining power with adjacent industries, and thus attain high profits. In addition, group profitability depends on the extent of intragroup rivalry. However, within strategic groups, firm profitability is determined by how well the firm's particular strategy insulates it from intragroup rivalry as well as other firm-specific characteristics such as its total scale and risk profile.

Two key competitive strategies, each delineating a dimension along which a configuration of strategic groups is formed within industries, are vertical and conglomerate integration. It is the central thesis of this study that traditional structure-performance

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models of industrial organization which usually posit that a firm's profitability is determined by both market share and seller concentration (or generally, the extent of horizontal dominance) as well as the presence of industrywide barriers to entry, are incomplete. These elements of integrated industrial structure are omitted from such models; more precisely, consideration is not given to the firm's strategic position within the industry defined, in part, by its degree of integration.

Apart from the impact that neglecting integration strategies has on the observed explanatory power of conventional structural elements, traditional analyses of industries comprised of integrated firms by and large evaluate the presence of corporate power within the industry without explicitly taking into account the multimarket nature of both the level and pattern of member firms' integration. The discussion of the degree of competition in the U.S. petroleum industry is a prominent example. The debate usually revolves around differing interpretations of the structural determinants of power (e.g., seller concentration) within the individual markets in which the firms primarily operate --

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crude oil production, refining, and retail product distribution. But the assessment of corporate power of firms extensively engaged in integrated market activity goes beyond a judgment on the state of competition within individual markets. Indeed, apart from the ability to exercise discretion which stems from their position within a given market, firms operating within a multilmarket industrial structure can devise more effective strategies toward collusion and exclusion than those available to firms that operate in fewer markets. Integrated firms may possess economic power even if the observed structural conditions in all of the individual markets are not consonant with those that are conventionally thought to confer such power. The extent of horizontal dominance observed in structure-performance models which assume away the multilmarket nature of integrated structure underestimates the true magnitude of barriers to new competition and the recognition of mutual dependence among competitors.

Overall, integration can be important. For this reason, the conventional analysis of oligopolistic interdependence needs to be

supplemented by structural elements that explicitly capture both the extent and pattern of integration; that is the general purpose of this study. By examining how several elements of intraindustry structure influence firm profitability, this investigation represents a deepening of the mainstream structure-performance approach to industrial organization.

In the first section of Chapter II the literature on intraindustry structure is critiqued. I argue that both the extent and patterns of firms' integration have received relatively little explicit theoretical and empirical attention in terms of defining configurations of strategic groups within an industry. The second part of Chapter II contains a review of the literature on integration. The presentation here shows that, despite a number of studies which maintain that integration is detrimental to competition only if a substantial degree of horizontal dominance is present in at least one of the markets in which the integrated firm operates, industrial organization analysis increasingly recognizes that integration per-se may be a source of market power. Finally, in the third section of Chapter II I suggest that by combining these two literatures it is possible to advance and test novel hypotheses relating integrated market structure and firm performance.

In Chapter III, the two principal hypotheses are outlined: first, that differences in "market positions" as well as "strategic positions" explain the dispersion of profit rates among firms within industries; and second, that both the firm's degree and pattern of
integration determine its intraindustry strategic position. In conjunction with secondary hypotheses, these become the basis for the development of a model relating elements of industrial structure to firm performance.

Using econometric techniques I test the fit of this model, for a cross-section sample of U.S. firms from the petroleum refining industry, in Chapter IV. Past empirical assessments of the intraindustry structure-performance theory have not restricted the analysis to firms within a single industry. But by doing so, a more direct test of the theory is possible: what may be key strategies for firms to pursue in one industry (e.g., due to an inherent technology) may prove to be less important in others, and it would be almost impossible to measure precisely strategic differences between firms in disparate industries. Because integration is such a prominent attribute of its member firms, it seemed particularly appropriate to confine the investigation to the petroleum industry.

Policy implications of the study's findings are considered in Chapter V. To the extent that the proposed framework offers insights into the state of competition within industries that are not revealed by conventional industrial organization analysis, some rethinking of antitrust policy might be in order. In addition, the examination of the performance of firms variously positioned within the petroleum industry may be of interest to persons responsible for formulating national energy policy, especially given recent debates over the social
desirability of vertical and conglomerate integration by petroleum firms. 5

II. A SYNTHESIS OF THE LITERATURES ON INTRAINDUSTRY STRUCTURE AND INTEGRATION

II.A. Introduction

The traditional methods of analyzing oligopolistic interdependence from the theories of Chamberlin\(^1\) to Stigler\(^2\) have assumed that all oligopolistic sellers share the common goal of maximizing joint profits, even though such congruence may conflict with each firm's individual objectives. In this context, the conventional structure-conduct-performance model of industrial organization is predicated on the assumption that industries are composed of a homogeneous population of firms. These firms share, in proportion to their sales, market power arising from the presence of structural elements that foster the recognition of mutual dependence among existing competitors and deter the entry of new competitors.\(^3\) Thus, other than for differences in size, firms within an industry are


treated as identical in all economically important dimensions. Apart from the effects of stochastic events, it is assumed that above-normal profits accrue equally to all firms industrywide.

But this theory of "shared-asset" profit determination is inaccurate. All firms in the typical industry are not identical. Within a given industry, firms pursue very different competitive strategies and possess different structural characteristics, such as the extent of product diversification, product distribution arrangements, degree of vertical integration, and so on. In addition, considerable dispersion of rates of return earned on invested capital is frequently evidenced among an industry's member firms.

The gap between the observed impact of industrial structure on firm performance and the theory that is supposed to explain such a relationship necessitates refinement of the conventional structure-conduct-performance model. A number of recent theoretical and empirical studies investigate the structure within industries. In general, they posit that firms within an industry earn varying rates of return due to the existence of (i) "strategic groups," which enhance collusion among firms with similar structural characteristics and competitive strategies; and (ii) "mobility barriers," which inhibit firms' movements within the configuration of strategic groups and insulate those groups that possess such barriers from intraindustry (as well as extraindustry) rivalry.
In section II.B this new literature is reviewed. I argue that by relaxing the assumption of intraindustry homogeneity, the "intraindustry structure" paradigm offers an appealing and useful refinement of the conventional structure-conduct-performance model. Yet, while based on meaningful concepts, e.g., "strategic groups" and "mobility barriers," the paradigm as currently used does not permit a direct evaluation of the relationship between industrial structure and firm performance for integrated firms operating in multiple markets, an increasingly prominent attribute of firms in the economy.

This observation raises the issues of why it is important to consider integration explicitly in the context of the structure-conduct-performance relationship, and the way that firm integration might modify the intraindustry structure paradigm. To begin to address these questions, the literature on integration is evaluated in section II.C. There it is shown that the integration literature contains two opposing schools of thought.

One group of writers, which I refer to as the "horizontal dominance school," contends that only if there is substantial horizontal structural dominance observed in any one of the markets or stages in which the integrated firm operates, can market power be increased through integration. Therefore, integration cannot

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4. My use of the term horizontal dominance refers to the extent of the firm's sole or shared control over sales (or purchases) in a particular market, stemming from the firm's position in that market.
contribute independently to market power and hence should not be considered as a distinct structural element in models of economic performance.

In contrast, there is a considerable and growing body of literature which maintains that integration per se may be a structural source of corporate power. Writers in this tradition regard the presence of horizontal dominance as a sufficient rather than a necessary condition for integration to affect firm performance. But, although this line of reasoning suggests that integration should be considered as a separate structural element in formal models of firm profitability, I point out that empirical analyses have yet to incorporate explicitly such elements.

Finally, in section II.D I argue that by considering integration as a competitive strategy in the context of intraregional structure and affirming the long-standing presumption that integration per se does, in fact, matter, the conventional structure-performance paradigm can be usefully modified and expanded. Several important issues that are raised by a synthesis of the intraregional structure and integration literatures are then briefly discussed, to set the groundwork for the formal model developed in Chapter III.

II.B. Intraregional Structure: A Review of the Literature

Early students of industrial organization focused on the firm as the relevant unit for economic analysis rather than the industry, the influence of which on individual firms was presumed to be relatively insignificant. In time, however, the Bain-Mason school shifted the
emphasis to the study of industries, positing that the structure of the industry largely determined firm conduct, i.e., pricing behavior, advertising and research and development investments, and so on.\(^5\)

But the issue of how industry structure is determined went, for the most part, unanswered. One hypothesis that has been formulated only recently is that the structure of an industry is determined primarily by the nature of the competitive strategies pursued by individual member firms.\(^6\) The study of industrial organization has, in some sense, come full circle.

The earliest approach taken in the study of firm strategy was that of Chandler, who analyzed, through historical case studies of the largest U.S. industrial firms in the 1920's, why firms pursue certain competitive strategies.\(^6\) Chandler defined corporate strategy as "the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for the carrying out of these goals."\(^7\) His central thesis was that firms devise particular competitive strategies in response to the opportunities and the needs -- created by changes in

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technology, national income, and population — to employ or expand existing resources more profitably. Chandler argued that the predominant competitive strategies pursued by firms are vertical integration and product and geographic diversification.

Chandler's investigation revealed that firms within an industry need not choose identical corporate strategies, even if they share the goal of maximizing profits. This observation suggests that if competitive strategies differ among an industry's competitors, firm strategy might be treated as a stable and significant element of the overall structure of the industry — or more precisely, as an element of intraindustry structure.

Hunt was the first to introduce the concept of "strategic groups" — each group consisting of firms highly symmetrical in their corporate strategies — as observable elements of market structure. In his study of the major home appliance industry, Hunt demonstrated that the greater the number of strategic groups within an industry, i.e., the greater the asymmetry in the configuration of member firms' strategies, the more difficult it is for oligopolists to achieve tacit coordination. Thus, Hunt argued that elements of intraindustry structure have a direct effect on member firms' rivalry and ultimately on industry performance; in particular, the more asymmetric are firms' strategies the lower are expected industry profits.

Hunt's investigation concentrated on strategic differences among competitors' operations in the principal market. Newman focused more broadly on the key strategies noted by Chandler. He readily extended Hunt's analysis by showing that the direct effect of strategic asymmetry on intraindustry rivalry is the same for "extra-market" strategic differences as for "intra-market" strategic differences. Thus, by defining an industry as "heterogeneous" if its member firms differed greatly in their levels of extramarket activity and "homogeneous" if its member firms all had roughly the same level of extramarket activity, Newman found for a sample of chemical industries that the more "heterogeneous" the industry, the lower is its profit rate, all other things being equal. But, although Newman defined the configuration of strategic groups within an industry along the dimension of "extramarket activity," his model is not designed to explain differences in firm performance in terms of variations in the level of firm integration.

Both Hunt and Newman focused on the direct effect of strategy variations on industry performance; that is, how the presence per se of strategic groups influences oligopolistic rivalry in the industry. But strategic groups also influence industry performance indirectly through their effects on intergroup and intragroup rivalry. Several recent

10 studies have investigated these indirect effects. Caves and Porter discussed the importance of intergroup rivalry and Porter, in two separate studies, analyzed the effects of both intergroup and intragroup rivalry on industry performance. I now consider each of these in turn.

Caves and Porter argued that differences in firms' strategies—which define a configuration of strategic groups within an industry—imply differences in technologies and economic activities that make the standard sources of entry barriers, i.e., economies of scale, product differentiation, absolute cost advantages, excessive capital requirements, and proprietary knowledge, vary by strategic group.

Entry can be easy into one of an industry's strategic groups and be blockaded into another. For instance, a strategic group composed of firms that sell heavily-advertised products has higher product differentiation barriers than a group whose goods are advertised much less; thus, entry into the former group is more difficult than into the latter. And, if entry barriers are group-specific and not entirely common to all firms in the industry, they impede not only the mobility of established firms from group to group, but the entry of new firms;


that is, the concept of entry barriers is framed more generally as mobility barriers.

In this sense, it is possible to advance the notion that mobility barriers (and hence strategic groups) amount to structural elements within an industry. Because mobility barriers offer dual protection from wholly new entrants into the industry and from intergroup entry by established firms, they provide an explanation for why some groups of firms in an industry consistently earn higher profits than others. Without such protection, firms with successful strategies would be quickly imitated by others and the profit rates among firms within an industry would equalize, all other things being the same.

While, of course, those firms which first recognize, as an industry's structure is formed, how differences in their initial tangible and intangible assets allow them to pursue profitable strategies successfully, Caves and Porter posited that, in general, mobility barriers may be generated by investments in power-creating assets that sacrifice immediate profits but provide for profits in the long run above what they otherwise would be. Some examples of such investments and their associated power assets are: research and development activity and patent control; advertising and product differentiation; and, one of the strategies focused on in the present study, vertical integration and control over raw material supplies and product distribution.
Building on the theory that mobility barriers indirectly affect industry performance through intergroup rivalry, Porter advanced several additional hypotheses: specifically, that intergroup rivalry is determined by the interaction between the number and size distribution of groups, the strategic "distance" between groups, and the degree to which the different strategic groups within the industry compete for the same customers. The more equal in size and the more numerous are the strategic groups, the more strategic asymmetry within an industry enhances intergroup rivalry. Similarly, the greater is the contrast in the key strategic variables that identify strategic groups; i.e., the greater the strategic "distance" between groups, the greater is intergroup rivalry. And, the more diverse the customer targets of the groups are, the more difficult tacit coordination becomes.

Here, Porter also argued that the presence of strategic groups indirectly affects industry rivalry (hence industry performance) through intragroup rivalry. First, intragroup rivalry is influenced by the number of firms within the strategic group. Thus, inasmuch as the number of resident firms may vary across strategic groups, mutual dependence should be more fully recognized within the groups that contain fewer firms. Second, although firms with similar strategies will likely be of comparable scale, the smaller firms within a particular group may face cost disadvantages where there are aspects of various strategies subject to economies of scale.
By combining the indirect effects of strategic groups on intergroup and intragroup rivalry with the direct effect of strategic groups on industry rivalry noted by Hunt and Newman, Porter then proposed a general theory of the distribution of profit rates among an industry's member firms determined by elements of intraindustry structure. Industrywide traits of market structure (e.g., industry growth, seller concentration) as well as intraindustry traits (e.g., the number and size distribution of strategic groups within the industry) affect the profits of all firms within the industry and hence the industry's average profitability. In turn, the height of mobility barriers protecting a particular strategic group, the position of the strategic group in the configuration of groups within the industry, and the group's bargaining power with adjacent industries and its exposure to substitute products determine the group's profitability. Finally, the performance of an individual firm is influenced by the number of members within the firm's strategic group, the firm's relative scale within the group, and the firm's ability to execute its own strategy in an operational sense.

In Porter's view, the principal implication of the theory was that different elements of intraindustry structure provide mobility barriers for different strategic groups within the industry. Thus, he envisioned a ranking of strategic groups within an industry, from those with the highest barriers to mobility to those that are relatively unprotected from entry. Overall, this suggested that different structural models should explain group performance (i.e., the average...
profit of firms in a strategic group), for differently situated strategic groups.

To test empirically this hypothesis requires that the strategic group be the critical unit of analysis. Porter attempted such a test in the following way. For each of thirty-eight consumer-goods industries (at the three-digit IRS level) he partitioned an industry's member firms into two strategic groups. Based on intra-market strategy differences, Porter defined the configuration of groups in each industry on the basis of firm size: each "leader" group was composed of the largest firms (on the basis of sales) in each industry and each "follower" group was composed of the (relatively) smallest firms in each industry. The average profit rate of (i) the leader group of firms and (ii) the follower group of firms in each industry, as well as, (iii) the average profit rate for each industry as a whole, were obtained (the dependent variables). The independent variables included the following elements of intraindustry structure: the number of firms in the leader or follower group; the ratio of advertising to sales for the leader or follower group; and the four-firm concentration ratio divided by the number of firms in the leader group. Other independent variables used had been included in conventional industrywide structure-performance models: the four-firm concentration ratio; an estimate of plant minimum efficient scale expressed as a proportion of industry sales; industry growth, and a dummy variable to control for regional industries. Three interindustry structure-performance models were tested: (i) leader group profit and (ii) follower group profit
were each regressed on various combinations of the independent variables, and (iii) average industry profit was similarly estimated (a conventional model). The results indicated that the model explaining leader group performance was substantially different from the model explaining follower group performance; there were important differences between the structural variables that explained profit levels for differently situated groups in an industry (e.g., advertising intensity was statistically significant and positive in the leader model, and negative, yet insignificant, in the follower model). Moreover, the explanatory power of each of the group structure-performance models was superior to that of the conventional industrywide structure-performance model.

Porter's theoretical and empirical contributions greatly enhance the intraindustry structure-performance paradigm. But, by defining strategic groups on the basis of size for his empirical test, Porter confused groups based on differences in scale with those based on differences in strategies per se: he has, in fact, focused on oligopoly groups rather than strategic groups. Though he acknowledged doing this for convenience, there is no necessary relationship between size and strategic differences. A superior test design would be one that permits an examination of strategies' impact on profitability after controlling for scale. Furthermore, this point suggests the need to measure strategic differences more precisely.
Overall, the literature on intraindustry structure refines the conventional structure-performance model. Studies in this tradition provide a more realistic explanation of economic performance than the traditional "shared-asset" analysis of industrial organization. Yet these studies raise a number of pertinent issues that go unaddressed. First, although the theory that evolves in this literature (articulated in its most complete form by Porter) readily offers the richest explanation of individual firm performance to date, there have been no attempts to develop and test an intraindustry structure-performance model at the firm level. Hunt and Newman investigated the performance of the industry and Porter focused on group performance. Clearly, such models cannot completely capture how strategic differences between firms within an industry directly influence profitability.

Secondly, all of the empirical tests examine the effects of intraindustry structure on performance on an inter-industry basis. Yet the theory is especially suited to explaining performance differences for a cross-section of economic units (either strategic groups or firms) within a particular industry. Moreover, by doing so, strategic differences could be measured with greater precision, thus bypassing the problems Porter faced.

Finally, and perhaps most importantly, elements of multimarket industrial structure -- the extent and patterns of firm integration -- have been considered only indirectly in the context of intraindustry
structure. Though the literature suggests that some forms of integration may inhibit mobility within an industry, the economic reasoning supporting this hypothesis can be developed further and generalized to include all forms of integration.

The implication of the preceding discussion is that multimeterk strategies can be incorporated as distinct elements of intraindustry structure in a model of firm profitability. But before serious consideration is given to how, precisely, this might be accomplished, it is imperative to develop more fully the way in which integration relates to firm performance. A review of the literature on integration establishes the foundation upon which such a relationship can be formulated.

II.C. Vertical and Conglomerate Integration: A Review of the Literature

This evaluation of the theoretical and empirical literature on integration begins by tracing the evolution of the hypothesis, embraced by some industrial organization analysts, that multimeterk activity is anticompetitive only if a substantial degree of horizontal dominance is present in at least one of the markets in which integrated firms operate. The focus then shifts to consider an established body of

12. Newman's study is the only one that explicitly incorporates aspects of multimeterk activity, but does so at the industry level, and is concerned with only the "direct" effects of intraindustry structure on performance.
studies that views the competitive impact of integration, per se, with suspicion. It is also shown that the courts' antitrust record on integration has tended to support the more conservative line of reasoning though there are indications that, at times, the courts have sought adherence to an economic theory that integration alone may lead to a loss of competition, only to find that one had not been developed rigorously.

Integration or multimarket activity is treated here as encompassing (i) vertical integration, the joining together of potentially separate successive stages of production under common ownership and (ii) conglomerate integration, which can be classified as: (a) product-extension integration — the expansion of a firm into production and/or distribution functionally related to its principal activity, but which results in products that do not compete directly with its principal products; or (b) market-extension integration — the expansion of a firm into different geographic markets, but selling in each the same products. It must be pointed out that although this taxonomy provides a convenient method for reviewing the literature, it

13. Strictly speaking, conglomerate integration may be classified into a third category: pure conglomerate integration — the joining together under common ownership of two or more quite separate production processes, having few or no production stages in common and resulting in different products.

Note also that by defining integration in terms of ownership I am excluding from consideration vertical control by contract, e.g., franchise arrangements, even though the motives for integration and such arrangements may be similar. As an empirical matter it is virtually impossible to obtain data on contractual relationships.
abstracts somewhat from the fact that often these forms of integration overlap, thereby making it difficult to make such clear-cut distinctions.

Apart from special conditions, such as technological coordination, where the incentive for vertical integration is perhaps obvious, 14 systematic discussion of this form of integration starts with Coase's analysis of the nature of the firm. 15 Coase recognized

14. While this point is usually asserted, the technology itself may not require vertical integration. Indeed, Kahn has argued that this is rarely the case: "The defense of vertical integration in [the telecommunications] industry is almost unique in its assertion of genuine managerial and technological benefits flowing from it. Not in petroleum, steel, cement, aluminum, motion pictures, or grocery distribution, in all of which integration has been both widely prevalent and strenuously debated, have its protagonists based their arguments so directly on technical grounds. The financial union of crude oil production and refining, iron ore mining and steel-making, the production of ingot steel and the fabrication of steel products, electric power generation and aluminum reduction, the production, distribution, and exhibition of motion pictures, the manufacture of cement and of ready-mixed concrete, the synthesis of nitrogen compounds and the preparation of mixed fertilizers, coffee-roasting and food distribution have all been defended on such grounds as the necessity for assuring a sufficient and regular supply of vital inputs, more effective marketing, the circumvention of monopoly, the saving of selling costs and -- it should be conceded -- the possibilities it afforded for a closer specification and control of quality, but rarely or never on the ground that the technological interdependencies were so close that each operation had to be done by the same engineers and managers working in close collaboration . . . One limited exception . . . would be the direct saving in fuel costs made possible by the transfer of pig iron in molten form from the blast furnace directly into the steel converter." (Alfred E. Kahn, The Economics of Regulation, 2 vols. [New York: John Wiley & Sons, 1971], 2: 300-01).

that a firm may want to bypass the price mechanism of open markets for the purchase of inputs or the distribution of outputs, and perform transaction functions internally because overall production costs might be reduced.

This view of vertical integration as a means of circumventing market transaction costs has been extended by others, notably Williamson.\(^\text{16}\) His major thrust is that the cost of using the market is likely to be high when there is "inherent uncertainty" about future market conditions or when there exists a small number of firms in the market, making the firm reluctant to deal openly in that market. But, like most of those adopting the transaction cost framework, Williamson defines the process that firms use to decide whether or not to undertake vertical decision-making integration too broadly.

To the extent that firms are risk averse, vertical integration has been hypothesized as a response to stochastic elements facing the firm. Thus several writers in this tradition have sought to show that firms will integrate vertically in order to reduce the impacts of (i) fluctuating input demands (Wu);\(^\text{17}\) (ii) price rigidities in


intermediate product markets (Green);\textsuperscript{18} or (iii) fluctuations in input supply prices with asymmetric information between participants at the upstream and downstream stages of production (Arrow).\textsuperscript{19} Recently, Carlton\textsuperscript{20} argued that the decision to integrate vertically can be regarded as a way in which firms transfer risk from one market to another. However, as Blair and Kaserman pointed out, insofar as free markets in the presence of uncertainty may be unable to allocate risk (and production) according to a social optimum, private incentives for vertical integration can exist even when such integration may not be socially desirable.\textsuperscript{21}

The theories of vertical integration associated with transaction costs and risk aversion detail incentives for multimarket activity without explicit assumptions about the competitive nature of any one stage of production. In the absence of transaction costs, risk, and uncertainty, and thus where the ideal world of perfectly competitive markets prevails, there may be little incentive for vertical


integration; this point is noted by Spengler\textsuperscript{22} and Adelman,\textsuperscript{23} among others. However, in cases where output or input prices are not given (e.g., the price of inputs exceeds their marginal cost), Machlup and Tauber\textsuperscript{24} and Hay\textsuperscript{25} have shown that firms integrate in order to overcome ostensible horizontal market power at one or more of the individual stages of production. Accordingly, the literature has turned its attention to how the incentive for vertical integration, under varying market structures, is altered with changes in the elasticity of (input) substitution. Major work in this area includes Burstein,\textsuperscript{26} Vernon and Graham,\textsuperscript{27} Schmalensee,\textsuperscript{28} Warren-Boulton,\textsuperscript{29}

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and Greenhut and Ohta. Briefly, if vertical integration leaves the cost conditions associated with each stage in the productive process unchanged, when inputs priced above their marginal cost are combined in fixed proportions to produce a unit of final output sold in a competitive market, the price and output of the final product will not change. Under the assumption of variable input proportions, however, vertical integration under these market conditions will result in a higher price and lower output level in the final market.

It is along these lines that the "horizontal dominance hypothesis" emerges, most forcefully by Bork, who has stated:

Monopoly power depends upon the percentage of the market occupied by the firm, and the ease of entry into that market. Vertical integration does not increase the percentage of the market controlled by the firm. It should be equally apparent that such integration does not impede entry into a market.

Phillips has also commented that, "vertical integration does not create monopoly power where no such power exists in at least one of the stages over which integration occurs."  


Extensions of the horizontal dominance hypothesis underlie notions that vertical integration enables firms to price discriminate, engage in price squeezes, and foreclose markets to competitors.

The courts have, by and large, supported this view. For instance, the concept of foreclosure was recognized by the Supreme Court in Brown Shoe Co. v. United States as an example of anti-competitive conduct stemming from vertical integration:

The primary vice of a vertical merger or other arrangement tying a customer to a supplier is that, by foreclosing the competitors of either party from a segment of the market otherwise open to them, the arrangement may act as a "clog on competition," which "deprives rivals of a fair opportunity to compete."37

Apart from Brown Shoe, the leading vertical case is duPont-General Motors.38 Overturning the district court's decision, the Supreme Court, in noting that the firm's market shares were significant, affirmed the notion of horizontal dominance and forced

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vertical divestiture:

Because General Motors accounts for almost one half of the automobile industry's sales, its requirements for automotive finishes and fabrics must represent approximately one half of the relevant market for these materials. Because the record clearly shows that quantitatively and percentagewise duPont supplies the largest part of General Motors' requirements, we must conclude that duPont has a substantial share of the relevant market . . . Thus, although duPont and General Motors are not competitors, a violation of the section [Clayton Act, Section 7] has occurred if as a result of the acquisition, there was at the time of suit a reasonably likelihood of a monopoly of any line of commerce.

As in the case of vertical integration, there is no single explanation why firms engage in conglomerate integration. At least four motives are recognized. Turner and Steiner have argued that conglomerate integration may lower total costs and provide true production economies. Strict adherence to this argument implies that holding total firm scale and demand conditions constant, the more specialized the firm, i.e., the fewer the number of markets it operates in, the higher will be its unit production costs. Of course, this abstracts from any economies of scale associated with indivisible inputs used in the production of individual products.

39. Ibid.


Another determinant of conglomerate integration may be the firm's desire to internalize risk and uncertainty. Thus, Williamson reasoned that the diversified firm is able to reduce risk over the business cycle more effectively than its less integrated counterparts. To a large extent, this hypothesis is analogous to those suggested by Green and Arrow explaining why firms integrate vertically.

The third reason frequently advanced -- by Stigler and others -- is that firms integrate in conglomerate fashion to take advantage of finance economies; that is, conglomeration enables the firm to allocate capital more efficiently than the market. (This notion is linked closely to the risk-internalization argument). But, it must be pointed out that individual investors are capable of diversifying their own portfolios at least as efficiently as corporate managers and according to their preference structures -- which may not be identical with the other stockholders' preferences or those of management.

Finally, conglomerate integration may be the result of (1) a growth maximization strategy, as articulated by Mueller; or (2) a revenue maximization strategy, as suggested by Berry. But, for

42. Williamson, Corporate Control and Business Behavior.
43. Stigler, The Organization of Industry.
example, Berry demonstrated that on average, firms integrate conglomerately into adjacent markets rather than into randomly selected ones in order to engage in product differentiation or price discrimination, a strong indication of conglomerate firms’ determination to maximize profits rather than sales per se.

As with vertical integration, the notion that competition is lessened only if horizontal dominance is observed in any individual market has been applied to conglomerate integration. Primarily two settings have been specified in this context:

(A) Reciprocal buying practices (purchasing supplies from those firms that purchase their own supplies from your firm). Allen⁴⁶ has argued that competition is reduced only if the firms command significant positions in their markets and the courts (e.g., F.T.C. v. Consolidated Foods Corp)⁴⁷ have supported such reasoning.

(B) Loss of potential competition (the removal of a firm that would actually have entered an individual market).

The courts (e.g., F.T.C. v. Proctor and Gamble)⁴⁸ and the

literature (e.g., Scherer)\textsuperscript{49} have reasoned (with some exceptions) that such an occurrence is injurious to competition only if the potential entrant merges with a dominant firm.

While subscription to the horizontal dominance hypothesis is characteristic of one school of thought, a number of students of industrial organization have maintained that both vertical and conglomerate integration do, in fact, have direct, though perhaps subtle, effects on competition. Writers in this tradition have sought to show that the level as well as the pattern of integration in an industry heighten corporate power.

This line of reasoning was first advanced by Edwards, in the context of vertical integration\textsuperscript{50} and more forcefully in the context of conglomerate integration.\textsuperscript{51} Edwards hypothesized that when large scale integrated firms face each other in a web of markets, they will compete less sharply than would less integrated firms occupying the same markets. In referring to conglomerate integration, he noted:

\begin{quote}
\end{quote}
When one large conglomerate enterprise competes with another, the two are likely to encounter each other in a considerable number of markets. The multiplicity of their contacts may blunt the edge of their competition. A prospect of advantage from vigorous competition in one market may be weighed against the danger of retaliatory forays by the competitor in other markets. Each conglomerate competitor may adopt a live-and-let-live policy designed to stabilize the whole structure of the competitive relationship. Each may informally recognize the other's primacy of interest in markets important to the other, in the expectation that its own important interests will be similarly respected. Like national states, the great conglomerates may come to have recognized spheres of influence and may hesitate to fight local wars vigorously because the prospect[s] of local gain are not worth the risk of general warfare.

Echoing Edwards' thesis, Blair argued that while there may be no true technical economies of vertical or conglomerate integration, pecuniary economies of absolute scale may arise, which permit integrated firms to derive market power from the existing industrial structure. For example, large-scale integrated firms can attain and maintain a greater cash flow, enabling them to support market cross-subsidization, predatory behavior, and the like.

The early attempt by Edwards in time prompted an increasing number of hypotheses about how integration might directly affect the prospects for both collusion and exclusion, and ultimately higher profits.

The investigations of the relationship between integration and

52. Ibid., p. 335

collusion focused on the increased opportunities for collusive agreements among integrated firms. For example, Kahn's study showed that the U.S. chemical industry is, in fact, comprised of hundreds of individual markets with many being supplied by the same set of firms. This led him to observe that in addition to the extent of seller concentration in particular markets, this pattern of multimarket activity probably increased the degree of collusion among firms. And he noted that, "an analysis of chemical markets requires something more than a consideration of the number of sellers in each separately." 54

Indeed, Adams has argued that, in general, the perception of firms' mutual dependence in any one market increases with integration. In particular, he demonstrated how parallel integration patterns heighten the prospects for collusion:

Suppose a firm sells in ten distinct markets with a share of ten percent in each. Suppose, further, that in every one of these markets, the firm has nine competitors, each also with a ten percent share. If the nine competitors in any one market have no positions in the other nine markets, the original firm has a total of ninety competitors. If, however, the nine competitors in any one market also have positions in each of the other nine markets, the original firm has a total of only nine competitors. While the intramarket fewness of sellers in these two examples is identical, the likelihood that sellers will recognize their interdependence in any given market is substantially greater in the latter case. 55


Reinforcing this notion, a study of the U.S. steel industry suggested that symmetrical patterns of vertical integration resulted in improved coordination among oligopolistic rivals across multiple markets.\textsuperscript{56} Such patterns of integration increase the flexibility for "side payments" -- the compensation paid by one firm to another for the privilege it receives in a jointly-conceived scheme of trade restriction.

Furthermore, Adams posited that collusion is fostered by parallel integration because cheating on the agreement is reduced: because the firm fears retaliation in a number of markets, the penalties for cheating can be much more costly in the multimarket context than if the firm operated in a single market. And, as Jones has shown for the case of vertical integration, multimarket activity per se provides additional information about a firm's behavior and thereby aids in the detection of cheating.\textsuperscript{57}

Consideration of the ways in which an integrated industrial structure might affect the prospects for exclusion focuses on the condition of entry into individual markets, as well as across multiple


\textsuperscript{57} Russell O. Jones, "Vertical Integration, Cartel Coordination, and the Petroleum Industry," (Ph.D. Dissertation, University of California, Santa Barbara, 1978). Jones also investigates the influence of vertical integration on petroleum firm profitability, but constructs a model which is substantially different than that developed in the present study.
Entry into an individual market may be blockaded at least three ways. First, as Rhoades noted, integrated firms can engage in predatory pricing to discourage new entrants since the losses the predators may sustain in the targeted market can be subsidized by gains made in other markets. Secondly, to the extent that integrated firms are required to report only consolidated profit statements, potential entrants may find it difficult to judge accurately the condition of entry into any one market, and the resulting uncertainty deters entry. This point has been made by Rhoades and others. Finally, building on Hines' notion that barriers to entry do not deter all potential entrants in the same way, Adams hypothesized that an established integrated firm may find entry into a particular market easier than a new non-integrated firm if the integrated firm has pre-existing collusive agreements in other markets with firms operating in the contemplated market.

But the focus on intramarket barriers conceals a potentially more important source of barriers to new competition in the context of


60. Adams, "Market Structure and Corporate Power."
integrated structure: independent from the degree of horizontal dominance present, a new firm may find it necessary to enter into a number of markets instead of merely a single market in order to attain at least the same scale, resources, and integration pattern as its established rivals. To the extent that this simultaneous multimarket entry increases the risk and, hence, cost for the entrant, the number of actual entrants will surely diminish.61

As this literature suggests, the prospects for collusion and exclusion depend not only on the extent of integration per se, but also the pattern of multimarket activity. In particular, it has been hypothesized that parallel integration may be important.

Parallel integration occurs when patterns of integration overlap and, as a result, the integrated markets are "linked." In developing his theory of duopoly, Henderson was the earliest to emphasize a linked oligopoly situation and the possible existence between competing firms of mutual interdependence and mutual restraint:

There may be thousands of grocers, yet each grocer will be intimately affected by a very small number of neighboring grocers, who may be close geographically or similar in type of customer to whom they cater... Industry is like a forest; each tree is far from almost all the rest but each has some close neighbors. What looks at first sight like an imperfectly competitive industry turns out to be a series of linked oligopolies. 62


Mueller refined the linkage concept by proposing that the nature of market linkages can be described as either horizontal, where each of a pair of firms produce the same product, or vertical, where each of a pair of firms produce a product that serves as a significant input for the other firm.

Solomon suggested that the degree of linkage might be an important determinant of performance in the U.S. banking industry, where linkages are created by banks operating in numerous geographic markets across a state. Following Solomon's lead, Heggestad and Rhoades' investigation of the impact of linkages on market rivalry represents the only empirical test to date of the linkage concept; their results indicated that across geographical banking markets, rivalry is tempered as the number of linkages increases. Yet, it should be pointed out that because their test pertains to a formally regulated sector of the economy a more general test of the concept is required.


II.D. Toward a Synthesis of the Intrahdustry Structure and Integration Literatures

Despite both the widespread recognition that multimarket activity is an increasingly prominent attribute of industrial economics, and the considerable theoretical attention devoted to it in the literature, systematic empirical investigation of the impact of integration on firm performance has been largely ignored. Since the horizontal dominance school stresses that any market power possessed by the integrated firm can be attributed to structural imperfections in the integrated markets, its proponents contend that the competitive assessment of such firms is straightforward: one merely judges the state of competition within the individual markets; if each of these markets appears competitive by accepted standards, then the integrated firm (or an industry populated by integrated firms) does not have a market power problem. The opposing school of thought maintains that horizontal dominance is a sufficient rather than a necessary condition for the exercise of market power. However, neither side has yet to subject this hypothesis to formal testing. The most appropriate way to discriminate between the two schools of thought is by developing a

model which permits a test of whether integration, after controlling for horizontal dominance, influences firm profitability: if there is no discernible effect of integration on profits, then, in general, it would be difficult to reject the horizontal dominance hypothesis; on the other hand, if integration increases market power a significant positive relationship should be revealed.

In the next chapter I formulate such a model by bringing together and building on the intraindustry and integration literatures. I argue that it is appropriate to consider strategies of integration as elements of intraindustry structure, and thus, to expect that integration per se increases firm profitability. In so doing I argue that, although on the surface the horizontal dominance notion is appealing, it is more realistic to believe that an integrated firm's power depends also on other, perhaps more subtle, characteristics of the industrial environment than that revealed in analyses of individual markets -- for example, multimeterk linkages. And, with the omission of these elements, the extent of horizontal dominance observed underestimates the recognition of mutual dependence among competitors and the height of barriers to new competition.

The theory of profitability that I develop pertains to the strategies of firms within a single industry, taking the firm as the critical unit of analysis. Moreover, because I focus on strategic differences at the firm level it becomes possible to measure such differences more precisely and to test for their profitability consequences more directly than previous intraindustry structure-performance studies.
CHAPTER III

DEVELOPMENT OF AN INTRAINDUSTRY STRUCTURE MODEL OF FIRM PERFORMANCE

III.A. Introduction

A central proposition in industrial organization analysis is that a firm's profitability depends on elements of market structure -- the extent of seller interdependency between competitors and the height of barriers facing firms contemplating entry. Though there are considerable differences in the ways these elements are incorporated in particular models, numerous interindustry studies offer empirical evidence confirming this hypothesis.1

Consider, however, such a model for firms within an industry. Ordinarily it is assumed that, perhaps except for variables depicting the firm's share in the market and size of assets, an intraindustry model of firm performance does not include the structural variables which pervade other profitability studies. The reason given for this omission is quite simple: structural elements do not vary within a single industry.2 Market power is assumed to be an asset shared by all

1. See Weiss, "The Concentration-Profits Relationship and Antitrust."
firms in an industry in proportion to their sales. Indeed, except for
random influences, long run profit rates of an industry's firms are
presumed to be equal.

But, in fact, the competitive strategies of firms differ greatly
within many industries. Moreover, a typical industry's member firms
earn rates of return on invested capital that exhibit considerable
variance over the long run. Surprisingly, there have been few serious
attempts to study systematically the determinants of the dispersion of
profit rates among firms within an industry.

In this chapter I develop a model of firm performance which
incorporates elements of both intraindustry and industrywide structure.
The model is devised to explain how differences in competitive
strategies of integration can account for variations in performance
between firms which populate an industry and thus relaxes the
traditional assumption of intraindustry structural homogeneity. As
such, the model bridges and draws from two separate bodies of
literature reviewed in the previous chapter: the literature on
intraindustry structure and that on integration.

There are three principal objectives this model is designed to
achieve: (i) to test empirically the "horizontal dominance hypothesis"
introduced in Chapter II, which posits that integration does not
directly affect firm performance; (ii) to discriminate between the
influence of conventional and intraindustry structural elements on firm
profitability; and (iii) to examine to what extent the determinants of
firm profitability differ when the configuration of strategic groups is
defined along the key strategic dimension that characterizes an industry. (In the present investigation this key strategic dimension is vertical integration.) The model is estimated for a sample of firms from the petroleum refining industry in Chapter IV.

In Section III.B. the theory of firm performance is outlined and the basic model is presented.

III.B. The Underlying Theory of Firm Performance

In general, among firms that populate an industry, profitability will depend primarily on two major structural elements: (i) the firm's "market position" and (ii) the firm's "strategic position" within the industry. The market position of a firm refers to the extent to which the firm derives market power directly from its standing in the number and size distribution of sellers in the industry and the prevailing scheme of buyer preferences. A firm has market power if it has the ability to exercise discretion over price and/or faces both a different portfolio of investment opportunities than that available to other firms in the industry and different payouts to equivalent investment opportunities. The determinants of a firm's market position are those factors that permit the firm to participate directly in oligopolistic

coordination and achieve some degree of horizontal dominance in the market. Such factors usually form the basis for conventional structure-performance models of firm profitability.

The strategic position of a firm depends, in part, on the firm's strategic group membership and, in part, on the firm's standing within a strategic group. Thus, market power stemming from a firm's strategic position can be considered to be partly strategic group-specific and partly firm-specific.⁴

Strategic group-specific market power is determined by two broad elements of strategic group structure: group interdependence and mobility barriers.⁵ Both the number and size distribution of firms in a strategic group and the degree of strategic symmetry among such firms (influencing their opportunity to interact via common customers, suppliers, and so on) will affect the extent to which mutual dependence is recognized. Within the industry as a whole, strategic differences among firms causes interdependence to be recognized more fully within strategic groups than between such groups. Moreover, members of a strategic group will not only react to disturbances in similar ways but are more likely to react to each others' actions in the

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⁴ Of course, market power derived from horizontal dominance is partly oligopoly group-specific and partly firm-specific, as I argue below. This factor has been incorporated in conventional models; see, e.g., Shepherd, "The Elements of Market Structure."

⁵ This point follows from Porter, "The Structure Within Industries and Companies' Performance."
marketplace. 6

The common strategies that define strategic groups imply that the standard structural sources of entry barriers are strategic group-specific, impeding intergroup (or intraindustry) mobility, as well as prohibiting new firms from entering the industry. Strategic groups that have a considerable degree of interdependence and possess high mobility barriers will attain high profit rates on average. 7

The elements of strategic group structure that allow such groups to attain market power are images of the common competitive strategies of individual firms that populate the strategic group. But within strategic groups, firm strategy differs: an individual firm will pursue its own strategy which somewhat different than other firms within the strategic group. Such differences also amount to elements of industrial structure, ultimately determining the strategic position of an individual firm within the industry.

While firms within a strategic group share, to a greater degree than other firms in the industry, a common interest in increasing group profits, their interests conflict, as a result of differences in their competitive strategies, on the issue question of how this increased profitability should be allocated among the group. The outcome of this

6. Reactions are likely to be particularly strong when strategic groups are defined on the basis of multilmarket linkages, as I argue below.

7. This is the hypothesis that Porter attempted to test in "The Structure Within Industries."
conflict will be determined by the relative bargaining strength afforded by the strategic position of each firm. 8

Different strategic positions imply differences in durable firm-specific assets that will create a variance among firms' rates of return within the group as well as outside the group. Though fundamental strategic differences among firms may result from variations in their initial tangible and intangible assets, a firm may attempt to devise strategies that best satisfy its objective -- presumably long run profit maximization -- if the competitive environment changes. But initial strategic differences may play a large role in the firm's ability to modify its strategy. For instance, later entrants may face cost disadvantages if there absolute cost advantages of being early in locating raw materials. 9 Thus one source of mobility barriers may be found in the historical development of an industry. In the oil industry, for example, later entrants faced crude inputs that were more costly to extract than established firms' supplies; as a result newer entrants found it more costly to replicate earlier strategies. On the other hand, it is also possible that the competitive environment can change such that strategies that were once advantageous become costly to entrenched firms; in such a situation new

8. This bargaining strength is analogous to that derived from the firm's market share, as described by Gale, "Market Share and Rate of Return."

9. Similarly, later entrants may face cost disadvantages when brand names and patent control already have been established.
entrants may face lower costs of mobility.

Overall, differing costs of mobility ultimately generate variations in firm performance. A firm in a strong strategic position has systematic advantages over other firms in the industry; and if the cost of mobility is high for its rivals, a firm’s successful strategy may be difficult to replicate and profit rates may not equalize. 10

The argument presented here is that the strategic position of a firm takes into account both (i) the firm’s strategic group membership and (ii) its standing within a group. 11 But a strategic group need not contain a set of firms; an individual firm can constitute a strategic group. 12 Therefore, the concept of strategic position can be framed to encompass the structural elements pertaining to firm strategy alone. Adopting the firm as the critical unit of analysis, it is possible to envision a continuous configuration of strategic positions -- each position occupied by a firm in the industry -- along each strategic

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10. In this sense, mobility or strategic replication can come about only by a change in strategy, not from operating a given strategy better. Operating a particular strategy better is analogous to becoming more "x-efficient," and enhancing performance somewhat in the short-run. In general, at a given point in time there is an upper limit to the profits that can be extracted by pursuing a particular strategy. Presumably all firms try to reach this limit, but some may be more successful in actually doing so.

11. Of course, the firm is a member of several strategic groups, one for each strategic dimension that characterizes the industry.

12. Porter, in "The Structure Within Industries," also allows for this possibility.
dimension that characterizes the industry. Thus, for each competitive
strategy, differences in the way firms are strategically situated in
the industry can be depicted by a continuous variable measured at the
firm level.

In general, a firm will have a high rate of profit if it
maintains a strong strategic position in the industry. A firm's
competitive strategy will afford a strong strategic position to the
extent that it insulates the firm from intraindustry (and
extraindustry) rivalry, permits the firm to engage in collusive
agreements with a considerable degree of bargaining leverage, and
provides the firm with a greater sensitivity toward the actions and
reactions of its rivals.

Altogether, this framework posits that, among all firms in an
industry, firm profitability can be explained by the firm's market and
strategic position, when the latter implicitly incorporates both the
firm's strategic group membership and standing within the group by
assuming that each firm constitutes a strategic group.

However, if the firm's strategic group membership and standing
within the group are explicitly taken into account by partitioning the
industry into strategic groups (with group membership based on the
firm's position along the strategic dimension in question), the
determinants of firm performance (i.e., the model explaining firm
profitability) will differ across such groups. Different structural elements will affect the pattern of rivalry and provide barriers to new competition for the typical firm situated within a well-protected strategic group than its counterpart residing in a less-protected group. Such differences are likely to be most pronounced when strategic groups are defined along a strategic dimension that, for reasons related to the industry's historical development or the nature of its technology, is key for sustained successful performance.

The theory that has been presented implies that the effect of a firm's market position on profitability is independent of the firm's strategic position in the industry. However, it may be the case that the influence on profitability of a firm's market position depends on its strategic position. A firm in a given market position may be more able to maintain excess profits if it is protected from rivalry by mobility barriers afforded by a strong strategic position. Similarly, given its strategic position, a firm may be more able to realize above-normal profits if it has attained a strong market position. Overall, then, rather than having an additive impact, market position and strategic position may interact in their determination of a firm's

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13. This hypothesis is analogous to that posited by Porter in "The Structure Within Industries," except that here I suggest how the determinants of firm performance vary across strategic groups within a particular industry) rather than how the determinants of group performance vary across industries. But, here it is possible to form strategic groups of firms directly, rather than using oligopoly groups as proxies.
The preceding analysis outlined a general theory relating elements of industrial structure to firm performance. I now consider these elements more specifically by discussing the determinants of a firm's market and strategic position with reference to particular structural variables.

**Determinants of Market Position**

The market position of a firm is determined, in part, by oligopoly group-specific elements and, in part, by firm-specific elements which together delineate the extent of a firm's horizontal dominance in the industry.

**Seller Concentration.** Seller concentration depicts the facility of tacit collusion between the firm and its rivals, as well as the effects of past oligopolistic agreements. The typical industry is composed of numerous geographic and product sub-markets, which differ in terms of the number and size distribution of firms that populate them. This fact implies that, on average, some firms in an industry may operate in more concentrated markets than others. However, while the leading-firm oligopoly group may directly influence firm profitability, i.e., the benefits of horizontal market power achieved by the oligopoly group are shared among all firms in a market, it is likely that the effect of concentration depends on firm-specific elements of horizontal dominance, in particular, the firm's market
Market Share. The extent of a firm's market share determines its ability to slant collusive agreements to reflect its own interests and thus increase its profitability, perhaps at the expense of smaller share firms. Therefore, by enhancing a firm's oligopoly bargaining position, firm-specific horizontal dominance is behaviorally related to market power. In addition, for a given level of concentration, an increase in a firm's market share will result in a more asymmetric size distribution of firms and heighten the prospects for the oligopoly group to jointly restrict trade and maximize profits. In other words, a large market share may increase profitability by allowing the firm to participate in an effective oligopoly group.

Though there appears to be general agreement among students of industrial organization that market share may be an independent source of market power, there is less agreement that the theoretical foundation of such a relationship is well-grounded. 14 Controlling for cost advantages that result from scale efficiency, this relationship implies that a high share firm possesses intangible rent-yielding

assets that allow increased profits to be realized apart from those accruing from its participation in market coordination activities with oligopolistic rivals. Such assets serve to lower the demand elasticity for the firm's products by altering the prevailing scheme of buyer preferences. Distinct from explicit product differentiation policies, the direct effect of market share on profitability may ultimately depict the influence of any (potentially nonreproducible) inherent differentiation associated with leading-firm products on the preferences of risk-averse buyers. 15

Determinants of Strategic Position

Within every industry there is a set of competitive strategies available to firms for achieving and preserving market power. Firms that extensively pursue these strategies, and thus occupy dominant strategic positions, are more capable of insulating themselves from rivalry and engaging in collusive activities. Strategies of integration, both vertical and conglomerate forms, are prominent characteristics of firms populating numerous industries; this is particularly true for the petroleum industry worldwide. Below I

15. See Joe S. Bain, Industrial Organization, 2d ed., (New York: John Wiley & Sons, 1968), pp. 238-50; Gale, "Market Share and Rate of Return;" and Rhoades, "Market Share as a Source of Market Power." The notion here is that consumers differentiate between products that are market leaders and losers: products with the largest share of the market are considered better solely because they are market leaders.
consider how firms that pursue these strategies exercise leverage over less-integrated members of an industry. In so doing, I draw on the integration literature reviewed in Chapter II.

While the following analysis attempts to distinguish between the competitive aspects of various strategies of integration, as pointed out in the previous chapter many of the incentives for vertical integration are similar to those for conglomerate integration. In fact, Gort hypothesized that firms view these two forms of integration as substitutes. The underlying argument in the present analysis is that although the practical consequences of one form of integration are essentially the same as those associated with other forms, it may be the case that a particular integration strategy presents a broader set of behavioral options to the firm; firms may tend to specialize in individual strategies, or they may attempt to maintain strong positions along a number of strategic dimensions.

Vertical Integration. There are principally two ways that vertical integration can heighten barriers to mobility within an industry and create market power that otherwise would not result from horizontal elements alone. First, a strategy of vertical integration

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17. To the extent that vertically integrated firms do not report profits on a (vertical) market-by-(vertical) market basis, a third source of mobility barriers can be identified. This point is developed more fully in the case of product-extension integration below.
may confer an absolute advantage in the matter of production and distribution costs. The vertically integrated firm's costs, at any comparable scale of operation, may be lower than those of non-integrated potential competitors. Investments in developing the capacity to produce inputs and/or in building an in-house product distribution network, which may entail a high degree of risk and the sacrifice of short-run profits, actually represent investments in the intangible asset of greater control over the configuration of market prices and output (and/or inputs). In the long run, this asset allows the vertically integrated firm to obtain a price which is some amount above cost while a non-integrated potential competitor, forced to match this price but unable to cover its own (higher) cost, would be deterred from direct rivalry (or more generally, entry).

The second barrier to mobility created by vertical integration, that of increased capital requirements, is associated with the absolute cost disadvantage effects. A potential competitor contemplating entry into an integrated market must obtain a larger amount of capital than that required for single level entry. And because capital markets are imperfect, this greater quantity of capital can be acquired only at higher relative costs to offset the increased risk associated with such an investment.

These mechanisms by which strategies of vertical integration lead to higher mobility barriers (and thus higher profitability) may be intensified as firm scale increases. Large scale vertically integrated firms should have an even greater absolute cost advantage to the extent
that there are captive economies of scale at the firm level associated with vertical integration. Moreover, because firms of large scale per se might enjoy preferential access to investment funds from external sources,\textsuperscript{18} as well as having more internal funds available, such firms that also are integrated may enjoy an even greater cost advantage. And potential competitors forced to attempt multilevel entry may find it especially difficult to obtain the capital required to match the integrated strategy of a large scale firm.

It has been argued that strategies of vertical integration can enhance a firm's market power independent from its market position. Yet if the firm operates in an oligopolistic market structure, vertical integration may encourage the firm's oligopolistic conduct. Successful tacit collusion requires that participants clearly communicate their production plans or pricing conduct and are deterred from cheating on the agreement. By operating in several vertically-related markets, the firm's operations at one level will be reflected in its operations at another stage. In this context, the vertically integrated firm can thus signal its intentions more effectively and reassure rivals of its commitment to the agreement. But at the same time vertical integration allows a firm to participate in an oligopoly group's restriction of trade and interdependent pricing, it also provides the mechanism by

which the firm is dissuaded from cheating on the agreement: cheating at one level will impact production plans at other levels and the opportunities for detection will thus be multiplied. Overall, then, vertical integration may increase the profitability of a firm that operates in concentrated market environment.

Product-Extension Integration. As one form of conglomerate integration, a strategy of product-extension integration shares the absolute cost advantage and increased capital requirements mechanisms associated with vertical integration, providing the firm with the ability to exercise market power even in the absence of horizontal dominance in any one product market. However, product-extension integration may provide another source of barriers. In particular, it creates the opportunity for the firm to set its price in a particular product market below cost and subsidize this conduct with profits earned in other (unrelated) markets. In this way, a strategy of

19. Rhoades, in "The Effect of Diversification on Industry Profit Performance," has argued this point and found evidence to confirm it using the industry as the unit of analysis. He also suggested that the potential for predatory cross-subsidization is a barrier in the context of vertical integration. This point was controversial in the debate over the social desirability of vertical integration in petroleum when the depletion allowance for refiners integrated into crude production was fully in effect prior to 1975. (Compare Melvin de Chazeau and Alfred E. Kahn, Integration and Competition in the Petroleum Industry [New Haven: Yale University Press, 1959]; with Richard B. Mancke, The Failure of U. S. Energy Policy [New York: Columbia University Press, 1974].) The arguments turned on the extent to which the depletion allowance and associated taxes on U. S. crude oil production would motivate crude-rich U. S. refiners to price squeeze crude-poor U. S. refiners. In general, however, price squeezes in the context of vertical integration depend on the presence of horizontal dominance at one of the stages of production.
product-extension integration signals a credible threat to potential competitors that post-entry conditions in the targeted market can be made unprofitable, at least in the short run.

Moreover, to the extent that conglomerate firms are required only to report consolidated profit statements, mobility into particular product markets may be limited. Potential entrants unable to ascertain the condition of entry on a market-by-market basis are thus likely to permit the integrated firm to earn a lucrative return without fear of competition.

Like vertical integration, the potential for achieving market power through product-extension integration may be increased when the firm operates in concentrated markets. But while vertical integration will almost always yield information in one market about the firm's operations in other markets vertically related to the first, thereby providing the firm with a mechanism to signal more clearly its intentions, it is less likely that product-extension integration can offer the firm such an effective means to assure rivals, because the markets in this case may not be so closely related. On the other hand, if a firm attains a lucrative position in a concentrated market it has a strong incentive to protect itself from rivalry. To the extent that a product-extension integration strategy is particularly effective in erecting mobility barriers through predatory cross-subsidization, the more extensively a firm operating in a concentrated environment pursues such a strategy, the greater may be its ability to extract consistently high profits.
Parallel Integration. The analysis of the effect of integration on firm market power presented so far has focused on the degree of integration per se. But the pattern of the firm's integration, and the way in which it relates to the integration patterns of other firms within the industry, may also influence market power. In particular, if an integrated firm shares a number of markets with other members of the industry it is more likely to collude with these firms and more capable of impeding potential competitors' mobility, regardless of its horizontal position in individual markets.

When a firm's pattern of integration is parallel to, or overlaps with, that of other integrated firms in the industry, it is operating in multiple markets that, in reality, are linked together. Such linkages can occur across markets that are related in either a vertical, product-extension, or market-extension sense. In general, an integrated firm is more prone to react to the actions of, and thus more likely to collude with, those firms in the industry that have similar patterns of integration, as well as more likely to force its competitive conduct on lesser integrated rivals.

In discussing how the integration of refining with production acts as a barrier to competition in the petroleum industry, Adelman

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20. Thus, it is possible to refine further the definitions offered by Mueller in "Conglomerates: "A Non-Industry"." For example, a multiregional linkage in the context of market-extension integration occurs where firms producing the same product overlap across geographic markets.
pointed out the importance of overlapping patterns of vertical integration:

The exchange of information, noted earlier as an inevitable result of overlapping ventures...was greatly reinforced when the producers met also in many markets as refiners and marketers. They had a close check on their rivals' plans for expansion, and could see whether their hopes of cooperative conduct were justified or not. Since a company could not increase output [in one market] without building refineries and distribution terminals in other countries, the implied pledge not to expand output faster than the group interest would approve was reinforced by the lack of any place to put additional crude.

That the conduct of an integrated firm depends on its multimarket linkages with other firms in the industry can be illustrated more formally. 22

Assume there are two firms in the industry, each integrated into the same n individual markets. Total profit for firm 1 is the sum of its profits in each of the n markets:

\[ \pi_1 = \sum_{i=1}^{n} \pi_{1i}, \]  

where \( \pi \) is total profits.

Let R and C denote revenue and cost respectively. In addition, let "a" denote some action by a firm, e.g., a price or output decision. Revenue for firm 1 in the i-th market is:


22. For a slightly different illustration of this point see Heggestad and Rhoades, "Multimarket Interdependence and Local Market Competition in Banking."
and its cost is:

\[ C_{11} = C_{11} (a_{i1}, a_{i2}) \]

Equations (2) and (3) imply that firm 1's cost and revenue in the \( i \)th market are determined not only by its actions but by its integrated rivals' actions in that market. Finally, in place of the conventional single market oligopolistic reaction function, equation (4) depicts the operation of multimarket linkages through a multimarket reaction function:

\[ a_{j2} = a_{j2} (a_{i1}, a_{j1}) \text{ where } j = 1, 2, \ldots, n. \]

Firm 2's actions in every market are influenced by firm 1's action in market 1 and in all of the other (linked) markets in which they meet as well.

Now, total profits for firm 1 can be written as:

\[
\pi_1 = R_{11}(a_{i1}, a_{i2}) + \sum_{j=1}^{n} R_{j1}(a_{j2}(a_{i1}, a_{j1})) - C_{11}(a_{i1}, a_{i2}) - \sum_{j=1}^{n} C_{j1}(a_{j2}(a_{i1}, a_{j1}))
\]

Totally differentiating (5) we obtain:
Dividing through by $da_{11}$, setting the resulting equation equal to zero to obtain the first order condition for profit maximization for firm 1, and after some rearranging, we arrive at:

\[
\begin{align*}
(5') \quad \frac{\partial R}{\partial a_{11}} - \frac{\partial R}{\partial a_{12}} &= \frac{\partial R}{\partial a_{11}} - \frac{\partial R}{\partial a_{12}} \\
+ \sum_{j=1, \: j \neq i}^{n} \frac{\partial R}{\partial a_{j2}} \frac{da_{j2}}{da_{11}} - \frac{\partial C}{\partial a_{11}} da_{11} - \frac{\partial C}{\partial a_{12}} da_{12} - \sum_{j=1, \: j \neq i}^{n} \frac{\partial C}{\partial a_{j1}} \frac{da_{j2}}{da_{11}} da_{11}
\end{align*}
\]

Firm 1's simple oligopolistic interdependence with firm 2 in an individual market is reflected in the second term in equation (6). The third term, $\sum_{j=1, \: j \neq i}^{n} \frac{\partial R}{\partial a_{j1}} \frac{da_{j2}}{da_{11}} \frac{da_{j2}}{da_{11}}$, represents firm 1's interdependence with firm 2 across the linked markets. If seller concentration is substantial within an individual market we expect

\[
\frac{da_{j2}}{da_{11}} > 0
\]

and the firm's profitability is enhanced. However, even if the degree of horizontal dominance in individual markets is low, i.e., if
is close to zero, the linkage between markets created by parallel integration provides a mechanism by which the firm recognizes its interdependence with other firms in the industry: to the extent that \( \frac{\text{da}_{12}}{\text{da}_{11}} > 0 \) (in the third term), a multimarket reaction function exists which increases an integrated firm's market power.

Analogous to the degree of integration per se, a configuration of strategic groups, and hence strategic positions, is formed in an industry along the dimension of symmetric patterns of integration, or more precisely, the degree of multimarket linkages. But, a firm which is a member of a strategic group (or occupies a certain strategic position) based on its degree of integration per se may not belong to a strategic group with the same members as the first group (or occupy a similar strategic position) when the strategic dimension shifts to that of the degree of multimarket linkages. For example, two firms in the industry may operate in the same number of geographic markets, i.e., have the same degree of market extension integration, but not share such markets. Alternatively, firms may share markets but not have the same degree of integration. Generally though, there will be a tendency for highly integrated firms from the same industry to share a great

23. Of course, this point may apply to all strategic dimensions; recall Gort's hypothesis that some firms may treat vertical and conglomerate integration as substitutes.
number of markets. Indeed, multimarket linkages should have a greater influence on market power as integration increases.

The foregoing analysis suggested one way that multimarket linkages increase market power: by enhancing the degree to which the firm perceives its interdependence with rivals, opportunities for mutually desirable agreements are created when none otherwise would exist — that is, even if individual markets are not concentrated. But linkages per se promote collusion in two other ways.

First, parallel integration improves the coordination of maintaining collusive agreements, in that multimarket linkages increase the flexibility for making side payments. In return for disturbing one market the firm can compensate its linked rivals in other (perhaps distant) markets. A firm in this situation has available to it a wider range of possibilities to alter the terms of trade governing the agreement than if its integration pattern did not overlap with its rivals. Moreover, such a firm can more easily conceal its side payments from antitrust authorities. This fact may be particularly true in industries where the integrated firm shares input or distribution markets with suppliers or customers — as is commonly the case in petroleum — because side payments can take the form of bartering.

24. Side payments can be defined as "compensation paid by one firm to another for the privileges it receives in a jointly conceived scheme of trade restriction" (Adams, "Market Structure and Corporate Power," p. 530).
Secondly, the prospects for collusion are higher in the context of parallel integration because cheating on agreements is discouraged. Cheating is limited not only because parallel patterns of integration enhance its detection over and above that provided by integration per se -- as pointed out earlier -- but because the penalties for cheating increase with multimarket linkages. Retaliation can now be directed at several markets simultaneously, thus raising the stakes above what they would be if the firm's integration pattern did not parallel that of its rivals. In short, multimarket threats are more effective than their single market counterparts.

It remains to be shown how parallel integration heightens mobility barriers. Apart from its degree of horizontal dominance, an integrated firm wishing to enter a particular market faces a more favorable condition of entry to the extent that its integration strategies parallel those firms that sell in the contemplated market. Pre-existing agreements among multimarket-linked firms provide mechanisms whereby the integrated firm can offset in other markets any costs it imposes on the others upon entry. Less-integrated potential entrants are not able to offer similar collateral.

On the other hand, for a given degree of multimarket linkages, the ability to overcome mobility barriers may increase with the firm's participation in collusive agreements stemming from its horizontal dominance.
Other Sources of Intraindustry Differences in Firm Profitability

While the dispersion of profit rates among an industry's firms is determined primarily by differences in market and strategic positions, three additional elements may be influential in this respect.25

Scale. Total firm scale is a firm-specific determinant of profitability. To the extent that there are economies of scale at the firm level, large firms within an industry may enjoy relatively low costs (and thus higher profits).26 Their smaller counterparts may have greater difficulty in financing large lumps of capital, preventing them from attaining effectively competitive positions. But although

25. Strictly speaking, there may be two other elements one may wish to consider as influencing long-run firm profitability. First, perhaps firms with continually high profits possess superior managerial talent. However, this hypothesis is inconsistent with the existence of a relatively free market for such services. It is therefore likely that superior management has only a transitory effect on profits. A second possibility is that government regulations impinge differently upon firms within an industry. In this study a sample period is chosen where such regulations are less pronounced. It should be noted, however, that, if anything, the history of U. S. petroleum regulations suggests that such regulations have been devised in ways that would tend to bias the results against finding some of the hypothesized relationships in this study.

26. Interindustry studies of performance usually include a technological scale variable to describe entry conditions, e.g., the fraction of industry output accounted for by a plant of MES (minimum efficient scale). The present investigation, however, is an intraindustry study and MES thus remains constant across observations. Issues related to economies of scale at the plant and multiplant (firm) levels in refining are discussed in Chapter V.
large-scale operations may confer pecuniary gains, to the extent that increases in size contribute to added managerial costs, control loss, and other inefficiencies, large firms may enjoy power yet be relatively less profitable, all other things being equal.

Increasingly, total firm scale stems more from the firm's degree of integration than the extent of its horizontal dominance in the market. If the firm pursues integration strategies that are subject to captive economies of scale firm performance should be enhanced with size.

Foreign Investment. In the typical industry a number of firms have extensive investments in international markets. Generally, such investments can be considered as reflecting various integration strategies. For instance, vertical foreign direct investment, especially backward to raw material supplies, may increase domestic absolute cost barriers to mobility within an industry. Similarly, if the firm produces in foreign markets the same products manufactured domestically, such activity can be thought of as market-extension integration. A number of studies have suggested that foreign direct investment has a feedback effect on domestic market structure fostering oligopolistic interdependence among firms.  

However, the profile of a firm's foreign operations need not overlap with its strategy of integration. The firm may participate in overseas trading or portfolio investments but not engage in bona fide foreign production or distribution. It then may be important to control for profitability differences stemming from foreign activity alone. Such activity may influence firm performance to the extent that lower foreign taxation results in higher after-tax global profits. On the other hand, because tax regulations impinging on firms differ across countries, the net effect of foreign activity on profits may be indeterminate.

Risk. The conventional industrial organization analysis posits that under competitive conditions long run profits will equalize among an industry's firms after adjusting for risk differentials. The total risk of a firm can be divided into two components: financial risk and business risk. Financial risk arises from the financial structure of the firm. Within an industry firms differ greatly in the share of their total assets comprised by debt capital. In general, highly leveraged firms tend to face higher costs of equity capital. However, as the finance literature points out, the average cost of total capital is probably invariant with respect to financial structure.


Therefore, if accounting data on profits are used to measure firm performance, employing a rate of return on total assets will substantially eliminate the effects of financial risk on profitability differences.  

Business risk arises from the basic nature of the firm’s business environment. However, differences in business risk should be largely accounted for if consideration is given only to firms within the same industry. Nevertheless, to the extent that any doubt remains that violations of neoclassical assumptions explain the dispersion of profit rates among an industry’s firms, it is important to include explicitly a variable that depicts the degree of such risk associated with the firm. Generally, a firm belonging to a high business risk-class will have to offer a greater return to induce capital to participate than will less risky firms.

The Basic Model

The model of the determination of profitability across firms within an industry can be summarized in its functional form for the i\textsuperscript{th} firm as:

\[ \text{Profitability}_{i} = \beta_0 + \beta_1 \text{Business Risk}_i + \epsilon_i \]

30. Sunder has also made this argument. Alternatively one might include an independent variable depicting financial risk, but the adjustment may not be as complete. Moreover, as I point out below, to include such a measure will also cost a precious degree of freedom.

31. Although business risk will vary greatly across industries, some may argue that firms with different degrees of multilmarket activity actually may be operating in different business-risk environments.
Proftability_i = f(Market Share_i, Seller Concentration_i, Vertical Integration_i, Product-Extension Integration_i, Multimarket Linkages_i, Total Firm Scale_i, Foreign Investment_i, Risk_i).

The firm's overall market position is depicted by its market share and the degree of seller concentration (as a measure of the state of competition) within individual markets, which together represent the extent of its horizontal dominance. The firm's overall strategic position is depicted by its position along each of three (continuous) strategic dimensions: vertical integration, product-extension integration, and multimarket linkages (or parallel integration).

In the following chapter, this basic model is specified as a multiple regression model suitable for empirical analysis. Several variants of the model which take into account possible interactive influences on profitability, as well as provide the opportunity to compare the determinants of firm profitability across strategic groups within a single industry, also are specified and estimated.
CHAPTER IV

EMPIRICAL ANALYSIS

IV.A. Introduction

In this chapter the theoretical model developed in Chapter III is tested on a sample of U.S. firms from the petroleum refining industry. Vertical integration is the key structural dimension in petroleum. To test the theory that vertical integration -- one of several dimensions of multmarket activity considered in the model -- is a determinant of firm profitability, it is necessary to isolate one segment within the stream of vertical operations. A reference point must be established from which the boundaries of vertically related markets can be circumscribed in order to define vertical integration and measure horizontal dominance in vertical markets meaningfully. Studies of the petroleum industry traditionally have regarded refining as the industry's fulcrum. Refineries are virtually the only buyers of, and the sole means through which commercially useful products can be processed from, crude oil. Therefore, I control for the refining level in the stream of vertical operations by considering only petroleum firms engaged in refining. Accordingly, the variables

measured in the next section, IV.B, are defined on this basis.

Section IV.C describes the sample selection process. In Section IV.D, the regression models are specified and the test results are presented. Data sources are listed in the Appendix.

IV.B. Definition of Variables

Measurement of Firm Performance. An appropriate measure of firm performance is one that represents the true value of what are, in reality, marketable assets that confer on the firm the ability to exercise market power. Capital market-based measures of profit will reflect, on the basis of future expectations, an almost immediate capitalization of above-normal performance into the value of the firm's securities. Yet it is difficult to tell precisely when such capitalization will occur and how and when expectations form. Book value measurements, on the other hand, systematically reflect above-normal performance until such time as competition eliminates it. Accordingly, I employ reported accounting profits to measure firm performance.

Even though restricting the analysis to firms within the same industry should greatly minimize accounting differences, there nevertheless may be inconsistencies between accounting and economic profits because the profits reported by a firm depend on the particular accounting practices it adopts. While, in general, the sign and magnitude of the bias in accounting rates of return depend upon the depreciation schedule, the revenue-time stream, the firm's growth rate,
and its financial structure, if the errors introduced by varied or inappropriate accounting practices are not systematically correlated with the independent variables, the estimated structure-performance relationship, though perhaps less robust, is not biased.\(^2\)

However, there are reasons why errors in the profit data, if anything, will tend to understate profit rate differences. First, exceptionally profitable firms have the greatest incentive to adopt accounting conventions that understate their profits for tax purposes and decrease their vulnerability to unfavorable public opinion. Second, highly profitable firms may take some of these profits in the form of perquisites which are not reported as financial profits. Finally, if managers prefer to retain earnings rather than pay dividends, very profitable firms will underreport profits to maintain stockholder good will.\(^3\)

This understatement problem biases the research results against finding a statistical relationship between intraindustry structure and firm performance, although even if such a relationship is not discovered it nevertheless may be present. If the results do conform with our expectations, however, then there is reason to be confident that such a relationship probably does exist.

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3. Hall and Weiss discuss these reasons and others to explain why profit rate differences may be understated.
Having settled on using accounting data, the proper index to measure profit rates remains to be specified. The literature is extensive on this issue, yet no single measure emerges as theoretically superior. A number of studies argue for using the after-tax rate of return on stockholders' equity, since it is what managers, acting in the stockholders' best interest, presumably seek to maximize. While it is correct to focus on after-tax rather than before-tax earnings, since tax treatments may vary even among firms within an industry, this measure is not adjusted for variations in financial risk and has the disadvantage of being easily manipulated by overstating (or understating) equity, as discussed above.

A more precise estimator of profitability, therefore, is one that corrects for the financial structure, and hence financial risk, of the firm. Accordingly, I employ the after-tax rate of return on net total assets (RRASST), defined as the sum of net income (after taxes) and interest payments as a percent of net total assets. Not only is this accounting concept a more sensitive gauge of the extent to which the firm is free from competitive constraints, but it incorporates substantially all of the important economic resources used by the firm -- which is more in keeping with the notion that a firm possesses an entire portfolio of power-yielding assets, with some portion comprised of tangible debt and equity capital. Nevertheless, it is unlikely that the results would be changed significantly by the use of an alternative measure, though RRASST should give the best fit. 4

4. In fact, I compare the two measures below.


Measurement of Market Share. In order to define the firm's market position, it was necessary to determine the relevant product and geographic markets.

To resolve the issue of product market boundaries, which generally turns on the degree of substitutability from both the demand and supply sides, I divided activity in the petroleum industry into three stages of production: (1) crude oil production, (2) refining, and (3) marketing. If the firm participates in more than one of these markets, the value of market share associated with it should reflect the extent of its share in all of its markets. Therefore, I calculate an average of market share taken over the relevant markets, each market weighted in the average according to the sales mix of the firm (WMS). 5

However, before this calculation can be carried out, the geographic dimensions of each of these markets must be considered. Although the literature proposes at least three methods of delineating the geographic boundaries of markets -- paralleling the theory that within a geographic market there should be (i) a common delivered price for the product that is significantly less than what would have been charged by outside suppliers; (ii) a low geographic dispersion of production; and (iii) a small amount of inter-area product shipments -- in practice, the estimation of market boundaries is a complex task,

5. This weighting procedure has become common practice; see Hall and Weiss. Ideally, market share at these three levels should be based on sales (or value-added); for refining, sales at the refinery gate.
ultimately relying more on personal judgments. Fortunately, in the case of petroleum markets there have been some systematic attempts in this area which can serve as guides.

The geographic scope of the market area for crude oil was taken to be international, as a number of analyses have shown. Market share in crude production (MSPROD) was defined as the percent of crude oil produced by the firm worldwide.

For refining, I assumed that the appropriate geographic market dimension in the U.S. was regional. Indeed, a study by Scherer and others suggested the existence of five U.S. regional refining markets. Accordingly, to delineate U.S. refining market areas I used the five Petroleum Administration for Defense (P.A.D.) districts as approximations.

Defining the geographic markets for refining outside the U.S. was more difficult. Because it would be an almost impossible task

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7. The term "worldwide" excludes the Sino-Soviet bloc.


9. PAD I covers the eastern seaboard; PAD II the midwest; PAD III the southern gulf region; PAD IV the western mountain region; and PAD V the west coast. See Theresa A. Flaim, "The Structure of the U.S. Petroleum Industry: Concentration, Vertical Integration and Joint Activities," (Ph.D. Dissertation, Cornell University, 1977):120.
to measure precisely the geographic scope of all foreign refining market areas, national market boundaries were used as approximations. In particular, outside the United States, thirteen countries were selected as major refin ing centers: Australia, Belgium, Canada, France, Germany, Italy, Japan, The Netherlands, Saudi Arabia, Singapore, Spain, The United Kingdom, and Venezuela. In addition, the Caribbean region was included as a separate refining market. In total, then, data on refining output (proxied by refining capacity), by firm, were collected for nineteen international refining markets. If the firm refined in more than one of these markets, the value of market share in refining associated with it, (MSREF), was an average of its shares taken over the relevant markets, each market being weighted in the average according to the firm's market mix. However, because foreign trade constitutes a significant portion of domestic production and consumption of refined products in several of the non-U.S. markets the firm's share in output would be different than its share in sales -- the ideal basis upon which to measure market share. Consequently, for these markets an estimate of market share

10. A refining center was defined as major if it had at least 500,000 barrels/day refining capacity in 1973. Of course, these markets included only areas where the sample firms had refineries.

11. Together these nineteen refining markets accounted for 80 percent of the world's refining capacity (excluding the Sino-Soviet bloc). Obviously, however, because the firms in the sample did not own refineries in every country, an even greater percentage of each firm's refining capacity was actually accounted for.
adjusted for foreign trade was used in the averaging procedure. Specifically, I estimated firm i's share in refining market j as:

$$\text{MSREF}_{i}^{j} = \frac{Q_{i}^{j} - X_{i}^{j}}{TQ_{j}^{j} - TX_{j}^{j} + TM_{j}^{j}}$$

where $Q_{i}^{j}$ is the ith firm's output in the jth market, $TQ_{j}^{j}$ is total output by all producers in the jth market, $TM_{j}^{j}$ is total imports into the jth market, $TX_{j}^{j}$ is total exports by domestic producers, and $X_{i}^{j}$ is exports by the ith firm -- estimated by $(\frac{Q_{i}^{j}}{TQ_{j}^{j}})(TX_{j}^{j})$; i.e., it was assumed that the firm's share in exports was the same as its share in domestic production.\textsuperscript{12}

The geographic boundary for marketing of refined petroleum products is probably somewhere between regional (from the supply side) and local (from the demand side). The appropriate data, however, were available only for the United States, on a regional (the five P.A.D. districts) or state basis, and for motor gasoline at the retail level alone. Though only about 40 percent of the total refined product market is represented by retail motor gasoline, historically gasoline has been the most profitable refined product and the most important one sold at the retail level.\textsuperscript{13} Of course, to the extent that a firm

\textsuperscript{12} This procedure is analogous to that for adjusting seller concentration for foreign trade (which is also done below) presented in William James Adams, "International Differences in Corporate Profitability," Economica 43 (November 1976): 367-79.

markets gasoline at the retail level outside the United States, these
data may be less than ideal; unless the firm's foreign market share in
gasoline is similar to that in the United States, errors of measurement
will be introduced. As it turns out, however, foreign marketing of
U.S. firms is much less heavily weighted toward retail gasoline, so the
effect of any errors is likely to be small.\(^{14}\) Due to inconsistencies
discovered in the state data, market share in retail gasoline sales
(MSMKT) was calculated using the regional data, i.e., if the firm
marketed in more than one region an average of its shares was taken
over the relevant regions, each region being weighted in the average
according to the sales mix of the firm.

Finally, it was then possible to calculate a weighted average of
the firm's market share in crude production, refining, and retail
marketing, that is:

\[
WMS = w_{\text{MSPROD}} + w_{\text{MSREF}} + w_{\text{MSMKT}}
\]

where \(w_p, w_R,\) and \(w_M\) sum to unity. The ideal weights to use in this
procedure would be either final sales or value-added at each market
level. Unfortunately, such data were unavailable and physical volumes
were used instead.

**Seller Concentration.** The procedure for estimating seller

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\(^{14}\) Of those firms in the sample that market gasoline at
retail outside of the United States, foreign sales accounted for
roughly 20 percent of total gasoline retail sales, on the average.
concentration is analogous to that used for market share. The degree of concentration in a market was measured by the ratio of shipments of the four leading producers to the shipments of all producers (a four-firm concentration ratio). Given the existence of a worldwide crude oil market, calculating concentration in crude oil production (CRPROD), was not difficult.

Similarly, if the firm refined in more than one of the nineteen refining markets, the value of seller concentration associated with it (CRREF), was a weighted average, calculated in the same manner as MSREF. Yet, as in the case of measuring market shares in refining, because foreign trade plays a significant role in several of the non-U.S. refining markets, producer concentration would be a poor measure of seller concentration in refining. Accordingly, to measure concentration in these markets I used:

$$CRREF^j = \frac{Q4^j - X4^j}{TQ^j - TX^j + TM^j}$$

where the superscript "j" refers to the jth market and Q4 measures the shipments of the four leading producers in the market, TQ is total shipments, TX is total exports, TM is total imports, and X4 denotes the exports by the leading four producers -- estimated by \(\frac{Q4^j}{TQ^j}(TX^j)\), i.e., it was assumed that the leading four firms' share in exports was the same as that in domestic production. The procedure used to obtain a value of seller concentration in retail marketing (CRMKT) parallels that used for MSMKT described above.
Finally, in order to obtain a value of seller concentration to associate with each firm (WCR), a weighted average of concentration in crude production, refining, and marketing was calculated using the same weighting scheme applied in the estimation of WMS above, i.e.,

\[ WCR = \omega_{CRPROD} + \omega_{CRREF} + \omega_{CRMKT} \]

where \( \omega_p, \omega_R, \) and \( \omega_M \) sum to unity.

**Vertical Integration.** No single definition of vertical integration emerges in the literature as precise and quantitative enough to be consistent with the generally accepted requirements of an index to measure such integration. Consequently, the literature offers a number of indexes.

To compare the degree of vertical integration between industries or between firms in disparate industries, several financially based measures have been suggested, such as the ratio of value-added to sales;\(^{15}\) the ratio of corporate sales to gross corporate product;\(^{16}\) the ratio of value-added to the "final product value" of output;\(^{17}\) or

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the ratio of employment in "auxiliary" activities to aggregate employment. Yet, there are certain well-known disadvantages associated with using such measures. For example, the value-added to sales ratio is deficient in that it does not treat symmetrically both forward and backward vertical integration and because value-added includes accounting profits.

But if the focus shifts to firms within an industry, vertical integration can be compared more precisely with greater flexibility in devising an index that is both intuitive and appropriate for the theory of integration under examination. In particular, given that I define vertical integration as two or more separable stages of production combined under common ownership, both backward and forward forms of vertical integration can be compared between firms within an industry by using physical rather than financial measures. It is important, however, that such measures do not neglect some inputs or outputs at the expense of others that may be of less, but still considerable, significance.

The central issue, then, is to define the boundaries of vertical stages of production. This task may be problematic, as Gort has pointed out, to the extent that

within every establishment, the same productive functions may be conceived as a continuous process or, alternatively, subdivided into a vast number of separate operations each of which may be identified as a separate stage of production.

But, in practice, if successful separate production by at least some firms in the industry is observed, then there is reason to believe that the stages are, in fact, economically separable.

In the petroleum industry this separation is actually the case: one does observe firms engaged solely in either crude oil production, refining, or marketing — hence, the reason this trichotomy has been used as the basis for defining product market boundaries above. Therefore, using the refining stage as the point of reference, it is possible to devise both a physical measure of backward vertical integration into crude production and of forward vertical integration into retail marketing.

Backward vertical integration (BCKVI) is measured by the ratio of the firm's total crude oil production to total refinery runs. In general, the refiner who is more self-sufficient in crude, processes internally a greater percentage of crude.

Forward integration may take, primarily, one of two forms: the refiner may integrate into various levels of wholesale distribution, leaving retailing to others; or it may integrate through to retailing

19. Ibid., pp. 11-12.

20. Total crude oil production and total refining runs are both worldwide (except Sino-Soviet bloc).
by direct sales to end users, through company-owned and operated retail outlets, and through franchise arrangements with dealers. Because of data limitations, this study focuses on forward integration into retailing -- in particular, retail sales of motor gasoline.

Given that our definition of vertical integration turns on (common) ownership of stages of production, forward integration into retailing raises the issue of how franchise arrangements might be treated in the measurement of such integration. Some gasoline dealers own their outlets and operate them under brand franchises; other outlets are owned by refiners and leased to independent dealers. While it is plausible to argue that the first arrangement yields the refiner less control over product distribution than the situation where the refiner owns and operates the retail outlet outright (and is thus distinct from the control offered by what is usually meant by pure vertical integration), there is some disagreement, both in the theoretical literature on franchise agreements and in studies of gasoline marketing per se, as to whether the latter arrangement substitutes for bona fide vertical integration. However, as I pointed out Chapter II, it is likely that both the motives for and the control derived from vertical franchise agreements will be similar to those that exist in the case of vertical integration. Nevertheless, to be consistent with the measurement of backward vertical integration and to minimize the risk of overstating the degree of forward vertical integration, forward vertical integration (FWDVI) is measured as the percent of motor gasoline sales that were either direct sales to end
users or sales made through company-owned and operated retail outlets. Like both market share and seller concentration for retail marketing, the data for forward vertical integration were for the United States alone; yet, as explained above, because foreign retail marketing of gasoline by U.S. firms is relatively unimportant, any errors of measurement are likely to be small.

**Product-Extension Integration.** Product-extension integration (PEI) is defined as the percent of the firm's sales accounted for by non-petroleum products. Although a priori reasoning alone cannot provide a complete answer to the question of which definition of product diversification is most correct, this index is more consistent with the theory of integration being tested than some alternative measures. For example, simply counting non-primary product markets

---

21. As it turns out, the data are not precise enough to discriminate between contractual and non-contractual vertical arrangements. Moreover, because similar data are not available for the calculation of BCKVI, (there are long-term contractual arrangements between crude oil suppliers and refiners) it was important to treat both upstream and downstream vertical integration consistently.

It may be argued that vertical integration as measured herein, is too narrow and understates actual vertical control. In fact, it is likely that, if anything, the errors of measurement associated with vertical integration are not random. For instance, excluding franchise agreements probably understates the true values of FWDVI that are large by a greater absolute amount than small true values of FWDVI. Therefore, if these biases actually exist, the usual tests of significance will be biased toward a finding of statistical insignificance. See J. Johnson, *Econometric Methods* (New York: McGraw-Hill, 1963): 148-75.

would give undue weight to positions in diversified markets that, in the aggregate, contribute relatively little to the firm's total operations. While an ideal measure might have been a composite of both the number and distribution of diversified product markets, the necessary data were not available.

**Multimarket Linkage.** While multimarket linkages can occur across markets that are related in a vertical and product-extension sense, because those dimensions of integration are already depicted in the model, multimarket linkage is defined here in the context of market-extension integration. In particular, multimarket linkage (MKTLNK) measures the extent to which the firm's pattern of geographic integration in refining parallels that of other firms in the industry. Once again, refining is denoted as the pivotal stage of production.

The following methodology details how MKTLNK was constructed. Assume there are $n$ firms in the industry and consider matrix $M$:

$$
\begin{array}{cccccc}
M_{11} & M_{12} & \cdots & M_{1j} & \cdots & M_{1n} \\
M_{21} & M_{22} & \cdots & M_{2j} & \cdots & M_{2n} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
M_{n1} & M_{n2} & \cdots & M_{nj} & \cdots & M_{nn}
\end{array}
$$
Each element of \( M_{ij} \), denotes the number of refining markets in which the \( i \)th firm meets the \( j \)th firm. I define \( M_{ij} = 0 \) where \( i=j \), i.e., the matrix has only zeroes along its diagonal. Note that \( M_{ij} = M_{ji} \), i.e., the matrix is symmetric. Each row shows the number of refining market linkages that the \( i \)th firm has with each other firm in the industry. For each firm, MKTLNK is then calculated as:

\[
\sum_{j=1}^{n} M_{ij}
\]

that is, by summing the elements in the \( i \)th firm's row. Since the number of refining markets in this study is nineteen, that is the maximum value that any \( M_{ij} \) can assume.

**Total Firm Scale.** Total firm scale (SCLE) is measured by the logarithm of net total assets, since cost advantages (or disadvantages) are likely to be nonlinearly related to scale. And, while both a large and a small firm may face comparable costs in raising an additional one percent in assets, their costs may differ greatly if they seek to raise equivalent amounts of capital in absolute terms.

**Foreign Investment.** The extent of the firm's foreign investment (FI) was estimated by the ratio of net income earned outside the U.S. to total net income. The data to construct two possibly better measures, the portion of total assets that foreign operations comprise or the portion of total sales accounted for by foreign operations, were not available. These measures would tend to be free of any bias.
associated with the practice of transfer pricing.\textsuperscript{23} To the extent that transfer pricing between U.S. and foreign subsidiaries enables the firm to conceal some fraction of net income actually earned overseas, using an index of reported foreign net income may understate FI; on the other hand, transfer pricing to take advantage of lower foreign taxation could impute an upward bias to FI. A priori it is impossible to ascertain the net direction of this bias.\textsuperscript{24}

Risk. Differences in financial risk, in all likelihood, have been essentially eliminated by using the rate of return on assets (see the discussion in the previous chapter); here I consider a measure to control for differences in business risk.

Recent developments in the finance literature suggest that the only type of business risk that matters for any given investment is that which cannot be eliminated through diversification.\textsuperscript{25} In particular, the "capital-asset-pricing theory" posits that the cost of capital to a firm is a function of the nondiversifiable risk associated

\textsuperscript{23} By transfer pricing I mean an accounting procedure in which intracorporate sales and purchases may be artificially invoiced so that a greater percentage of total corporate profits accrue to those subsidiaries in low tax countries than subsidiaries in high tax countries.

\textsuperscript{24} Pugel, in International Market Linkages and U.S. Manufacturing, describes in detail possible biases in foreign investment data and the impact of such biases on estimating profitability.

with the return on that firm's capital. To the extent that this proposition is true, measures of business risk such as (i) the variance of the firm's profit rate or (ii) the standard deviation of the firm's rate of return about a trend line, are incomplete. Rather, a better measure of risk is one that accounts for the firm's performance relative to all other firms participating in the securities market. I employed as an estimate of risk (RSK) a measure suggested by the capital-asset-pricing theory. This measure is commonly called a "beta coefficient" and is defined as:

$$\frac{\text{COV}(R_F, R_M)}{\text{VAR}(R_M)}$$

where $R_F$ is the rate of return on the firm's capital and $R_M$ is the rate of return on a totally-diversified capital market portfolio.

Although, in general, data on "beta coefficients" are readily available, they only pertain to the market for equity capital. This measure of risk would not be a problem if our measure of profitability were based on equity capital alone; we then would expect to observe a positive relationship between risk and profitability. But the rate of return on total assets is actually a weighted average of the return on equity and on debt capital. In this case, an ideal risk measure would incorporate both types of capital. Unfortunately, the data to

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26. Surprisingly, such a risk measure has been scarcely included in structure-performance models, but see, e.g., Bothwell and Keeler, "Profits, Market Structure, and Portfolio Risk."
construct such a measure are not available. A priori, it is difficult to predict whether this equity-based measure of business risk also is related positively to the firm's return on total assets. In general, the direction of the relationship depends on the relative costs of debt and equity capital and the responsiveness of the firm to a change these relative costs. If equity capital is more costly and an increase in the cost of equity does not induce the firm to increase greatly its borrowing, the average cost of capital may increase (and the relationship between RSK and RRASST will be positive). On the other hand, if the firm facing high equity costs expands its borrowing significantly, the average cost of capital could fall (and the relationship between RSK and RRASST would be negative). However, an increase in leverage per se may force the firm to pay higher interest rates on additional bonds and counter the possibility of a negative relationship.

IV.C. Sample Considerations

Sample Selection Criteria. The sample was defined to include all publicly-held U.S. petroleum firms which had attained at least 40,000 barrels per day domestic refining capacity as of 1974, and for whom data were available on a relatively standardized basis for the years 1970-1973. Firms that experienced major internal disequilibria (e.g., a large-scale merger) or whose operations were subject to extraordinary government regulations (e.g., special tax-free status) were excluded from the sample. In total, the panel covered 27 firms,
though certain subsets within the panel were used for the specific analysis of the way in which the determinants of firm performance differ across strategic groups.

The premise for the sample selection is that, as a whole, the firms are representative of both the size distribution and scope of intraindustry structural patterns common to many industries. Although the 40,000 barrels per day cutoff was somewhat arbitrary, data on smaller firms generally were not readily available. Moreover, as previous research has shown, there can be significant biases in the way very small firms report profits, due to entrepreneurial withdrawals.

While the 27 sample firms accounted for only 20 percent of the individual refining firms operating in the U.S., together they represented more than 76 percent of total U.S. refining capacity; the average refining capacity by firm for all refiners operating in the United States was 109 thousand barrels per day and the standard deviation was 248 thousand barrels per day.

There are several reasons that the sample is comprised of only

27. I discuss issues related to MES in petroleum in Chapter V.


29. These figures were published on December 1, 1974, and are the only data available that take into account U.S. refining capacity as of December 31, 1973, the end of the sample period. Of course, they are for descriptive purposes only.
U.S. firms. First, even when engaged in similar economic activity (e.g., refining in the U.S.), firms of different nationalities tend to operate, overall, in very different legal and cultural environments and this fact may account for variations in firm performance. Secondly, reported profits may vary, not due to actual performance differences, but because of differences in accounting conventions that may arise between firms of different nationalities. These two considerations suggest that it is important to control for nationality; the most efficient method of accomplishing this objective -- restricting the sample -- was selected. Having thereby confined the investigation to firms of similar nationality, the U.S. was chosen because no other country has as large a number of structurally heterogeneous petroleum refiners relatively free from government ownership and control.

The four years between 1970 and 1973 provide a recent, relatively regulation-free period of appropriate duration to reveal systematic differences in firm profitability. The year 1970 was selected as the beginning of the sample period because extending the analysis to earlier years potentially would involve inaccuracies, due to a number of significant mergers that occurred in the late 1960's. The terminal year is 1973 because extensive regulation of the industry, particularly the crude oil entitlements program, started in earnest in 1974. Moreover, the immediate effects of the OPEC embargo on firm

30. See Adams, "International Differences in Corporate Profitability."
IV.D. Analysis of Empirical Results

Table 1 summarizes the variables and presents simple correlations between profitability and the independent variables for preliminary analysis.

The market position and strategic position variables are each related positively to profitability, as are scale and foreign investment. The equity-based measure of risk, however, is negatively correlated with the rate of return on total assets, though the coefficient is not statistically significant.31

Though not reported in Table 1, it is interesting to note that except for a positive relationship between backward vertical integration and multimarket linkages (market-extension integration), the simple correlations linking the various strategies of integration were all statistically insignificant; for this sample, then, the data cast doubt on Gott's hypothesis that firms view integration and diversification as substitutes. In addition, except for multimarket linkages, an increase in integration was not accompanied by a

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31. Simple correlations, however, do not control for the influence that other variables have on profits or risk. Note that this measure of risk was readily available for only twenty-three (out of the twenty-seven) firms in the sample. Using a rate of return on stockholders' equity (RRSTCK) a positive, though not significant, relationship did appear.
(statistically) significant decrease in risk.\(^{32}\)

**Specification of the Basic Model.** To obtain a specification suitable for empirical analysis, the basic cross-section regression model is expressed as:

\[
\text{RRASST} = \beta_1 + \beta_2 WMS + \beta_3 WCR + \beta_4 BCKVI + \beta_5 FWDVI \\
+ \beta_6 PEI + \beta_7 MKTLNK + \beta_8 SCLE + \beta_9 FI \\
+ \beta_{10} RSK + \epsilon
\]

where \(\epsilon\) is a random disturbance term. There is no a priori specification of the functional form of this model. It is natural to consider a linear specification as a first order approximation to an unknown underlying functional form.\(^{33}\) In this way, it is hypothesized that the structural variables have an additive impact on profitability; interactive specifications are considered below.

There are several reasons why a single equation model is specified. First, such a model is appropriate to test the

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32. Of course, to test more precisely that integration strategies are not substitutable or that integration does not decrease risk, fully specified models -- rather than simple correlations -- would be necessary.

33. However, recall that scale is expressed as the natural logarithm of net total assets.
structure-performance theory that I have outlined: (my) primary interest is to analyze the effects of structural variables on firm performance rather than to investigate the determinants of intra-industry structure. Secondly, if a simultaneous relationship does exist between profitability and industrial structure, it is likely that a dynamic framework is required. Needless to say, empirical studies of industrial organization have scarcely attempted to incorporate such a framework. Finally, most empirical structure-performance tests employing simultaneous models, on balance, do not reveal that serious biases are produced by single equation specifications.

The results of estimating several variants of equation (1) via least squares appear in Table 2. Because the assumption of homoscedasticity is not very plausible in cross-section microeconomic models a priori, I applied the Goldfeld-Quandt test to the OLS estimated residuals from equation (1). The test results strongly indicated that the disturbance terms were heteroscedastic: in particular, the variance of profit rates for large firms was less than that for small firms. Using the Park test, I found that the appropriate correction was to weight each observation


35. See, e.g., Pugel, pp. 94-95. In short, at this point in time, the quality of industrial organization data does not appear to justify overly-sophisticated econometric models.
<table>
<thead>
<tr>
<th>Variable</th>
<th>RRASST</th>
<th>Rate of Return</th>
<th>RRASST</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of Return</td>
<td>RRASST</td>
<td>.516</td>
<td>WMS</td>
<td>.516</td>
</tr>
<tr>
<td>Market Share</td>
<td>WMS</td>
<td>.516</td>
<td>WCR</td>
<td>.575</td>
</tr>
<tr>
<td>Concentration</td>
<td>WCR</td>
<td>.575</td>
<td>BCKVI</td>
<td>.515</td>
</tr>
<tr>
<td>Backward Vertical Integration</td>
<td>BCKVI</td>
<td>.515</td>
<td>FWDVI</td>
<td>.496</td>
</tr>
<tr>
<td>Forward Vertical Integration</td>
<td>FWDVI</td>
<td>.496</td>
<td>PEI</td>
<td>.043</td>
</tr>
<tr>
<td>Product-Extension Integration</td>
<td>PEI</td>
<td>.043</td>
<td>MKTLNK</td>
<td>.562</td>
</tr>
<tr>
<td>Multimarket Linkages</td>
<td>MKTLNK</td>
<td>.562</td>
<td>SCLE</td>
<td>.500</td>
</tr>
<tr>
<td>Total Firm Scale</td>
<td>SCLE</td>
<td>.500</td>
<td>FI</td>
<td>.463</td>
</tr>
<tr>
<td>Foreign Investment</td>
<td>FI</td>
<td>.463</td>
<td>RSK</td>
<td>-.133</td>
</tr>
<tr>
<td>Risk</td>
<td>RSK</td>
<td>-.133</td>
<td>RSK</td>
<td>-.133</td>
</tr>
</tbody>
</table>

NOTE: All correlation coefficients pertain to 27 observations, except for risk, where there were 23 observations. With n=27, a simple correlation coefficient of .32 is statistically significant at the .05 level; with n=23, to achieve the same level of significance the coefficient must be .35. All variables pertain to the four year period 1970-1973 as specified in the Appendix.
TABLE 2
FIRM PROFITABILITY REGRESSIONS FOR THE INDUSTRY: BASIC MODEL

<table>
<thead>
<tr>
<th>Equation:</th>
<th>(1a)</th>
<th>(1b)</th>
<th>(1c)</th>
<th>(1d)</th>
<th>(1e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>3.938</td>
<td>7.401</td>
<td>3.925</td>
<td>.595</td>
<td>-47.82</td>
</tr>
<tr>
<td>WMS</td>
<td>.172</td>
<td>.180</td>
<td>.171</td>
<td>---</td>
<td>.404</td>
</tr>
<tr>
<td>WCR</td>
<td>.075</td>
<td>.123</td>
<td>.075</td>
<td>.121</td>
<td>2.619</td>
</tr>
<tr>
<td>WCR²</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>-0.030</td>
</tr>
<tr>
<td>BCKVI</td>
<td>.014</td>
<td>.015</td>
<td>.014</td>
<td>.009</td>
<td>.016</td>
</tr>
<tr>
<td>FWDVI</td>
<td>.123</td>
<td>.138</td>
<td>.122</td>
<td>.117</td>
<td>.117</td>
</tr>
<tr>
<td>PEI</td>
<td>.038</td>
<td>.044</td>
<td>.038</td>
<td>.027</td>
<td>.052</td>
</tr>
<tr>
<td>MKTLNK</td>
<td>.023</td>
<td>.035</td>
<td>.023</td>
<td>.025</td>
<td>.026</td>
</tr>
<tr>
<td>SCLE</td>
<td>-.808</td>
<td>-1.435</td>
<td>-.801</td>
<td>-.459</td>
<td>-1.226</td>
</tr>
<tr>
<td>FI</td>
<td>-.001</td>
<td>-.014</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>RSK</td>
<td>-1.633</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

\[ R^2 \]  
\[ .8660 \]  
\[ .8306 \]  
\[ .8730 \]  
\[ .8464 \]  
\[ .8893 \]  
\[ n \]  
\[ 27 \]  
\[ 23 \]  
\[ 27 \]  
\[ 27 \]  
\[ 27 \]  

NOTE: Dependent variable is RRASST. t-statistics are given in parantheses. All equations are weighted to correct for heteroscedasticity. One and two stars denote statistical significance at the .05 and .01 levels (one-tailed), respectively.

a See text for significance test.
by \([\text{net total assets}_i]^{0.2}\). Accordingly, all equations, unless denoted otherwise, were estimated using weighted least squares (WLS).\(^\text{36}\)

In general, the results in Table 2 suggest that the economic theory underlying equation (1) receives strong support in this sample; that is, controlling for horizontal dominance, integration is an independent determinant of firm performance. Throughout, market share, concentration, backward vertical integration, forward vertical integration, product-extension integration, and multimarket linkages are all positively related to profitability and, except for concentration -- which is discussed below -- all of these elements consistently display a strong level of statistical significance.

These results were not materially changed when the rate of return on stockholders' equity (RRSTCK) was used as the profitability measure, except that the fit of regression equations is substantially better for RRASST. In fact, in every model estimated in this study the rate of return on assets performed better. Overall, the rate of return on assets may be the more appropriate measure to employ in analysis of

\(^{36}\) The Goldfeld-Quandt test is described in Stephen M. Goldfeld and Richard E. Quandt, Nonlinear Methods in Econometrics (Amsterdam: North-Holland Publishing, 1972). The Park test is suggested in R. E. Park, "Estimation with Heteroscedastic Error Terms," Econometrica 34 (October 1966): 886-91. This weighting scheme is consistent with other cross-section studies which have assumed (rather than estimated) weights (see, e.g., Gale). Though Goldfeld and Quandt point out that the procedure outlined by Park is not without problems, as a rule of thumb, it is probably the best way to determine the appropriate weight.
intraindustry differences in profitability.\footnote{Hall and Weiss argued that RRSTCK would be a superior measure in interindustry studies; however, it should be noted that they used an incomplete model. In the present investigation, when RRSTCK was used, the only noticeable difference in the individual coefficients was that WMS and MKTLNK were statistically significant at lower levels.}

Equation (1b) is not directly comparable to the other estimated equations; it is noticeably different because the limited availability of the risk variable necessitated narrowing the sample down to 23 (rather than 27) firms. (In a larger sample, a 15 percent reduction in sample size is also likely to have some impact on the estimates, though perhaps a less severe one.) In any event, not only is risk statistically insignificant, but the correlations between profitability and structural elements tend to hold up even when risk is included as an explanatory variable.\footnote{Equation (1b) was estimated using the rate of return on stockholders' equity (RRSTCK) as a dependent variable: Though RSK turned positive (as expected) it was still insignificant; the other variables (except MKTLNK) retained their statistical significance, though all at lower levels, and the equation's fit was not as good, but still highly significant. An alternative measure of business risk — the standard error of the trend line fitted to each firm's profit rates for the 1970-1973 period (INTMPRSK) — was tried for the 27-firm panel using both RRASST and RRSTCK. The results were much the same, except that INTMPRSK remained negative in the RRSTCK equation.}

The negative (though insignificant) coefficient on RSK agrees with the simple correlation analysis above and suggests that poorly performing firms may be forced to borrow heavily because of high equity costs.\footnote{This point was suggested to me by Theodore E. Keeler.}

Foreign investment (FI) never attained an appreciable degree of
statistical significance in any model that was estimated. Because of its high collinearity (.63) with MKTLNK (which depicts geographic diversification in refining), I tried deleting the latter from the equation; FI improved somewhat, but never differed statistically from zero. However, if FI is dropped from the model (with MKTLNK included), the goodness of fit and the standard error of the regression both improve. Taken together, these results imply that foreign investment per se, as measured by the percentage of total net income earned outside the U.S., appears not to influence U.S. petroleum firm profitability significantly in the sample period.40

In all cases, scale shows a negative association with profitability and, generally, at a strong level of statistical significance. This finding, consistent with interindustry studies of firm performance, suggests that there are not economies of scale associated with large firm size among this sample of petroleum firms.41 Two possible interpretations deserve consideration. The largest firms may have been limit pricing during the sample period to discourage new entry and restructure the industry to their long-term

40. Using RRSTCK instead of RRASST or entering FI either non-linearly or in dummy variable form did not change this conclusion.

41. Shepherd also estimated a significant negative relationship between firm size (measured the same way) and profitability for a large sample of firms from different industries. Interestingly, Armour and Teece also found that size did not enhance petroleum firm performance (it was statistically insignificant but positive), yet they measured firm size by net total assets per se.
advantage. Large-scale operations initially demanded by the pursuit of various competitive strategies were perhaps no longer required as economic conditions or objectives changed; indeed, large-scale operations may have become a burden, contributing more to costs (perhaps through x-inefficiency) than to pecuniary economies (market power) and technical economies. In fact, a survey of the contemporary business press reveals that during the 1970-73 period a number of the larger firms in the industry did begin to sell off some of their assets, notably retail marketing facilities in the U.S.\textsuperscript{42} The other possible explanation for the negative coefficient on SCLE is that government regulations (e.g., crude oil import quotas) during this period may have had the effect of subsidizing small domestic refiners at the expense of their larger counterparts.\textsuperscript{43} Yet even if regulations did play such a role one cannot rule out the possibility that size is positively associated with market power.

Concentration is consistently positive, but generally not statistically significant as an independent influence on profits. A number of factors may be responsible for this result. Given the construction of WCR, it is not surprising that its standard deviation

\textsuperscript{42} For instance, Texaco, which once prided itself on marketing in fifty states, began to retrench from this position in the mid-1970s.

\textsuperscript{43} This argument has been made by several persons including Edward J. Mitchell in U.S. Congress, Senate, Committee on the Judiciary, The Petroleum Industry-Vertical Integration, Hearings before the Subcommittee on Antitrust and Monopoly on S. 2387. 94th Cong., 1st sess., 1976, pp. 1849-90.
in the sample is quite small (3.81); its mean is 43.0. Secondly, it is moderately collinear with WMS (r = .59), as might be expected. This collinearity is common in studies of this type and little can be done to mitigate it. Equation (1d) omits WMS, yet WCR only barely attains statistical significance; other structure-performance studies also have shown that when market share is introduced concentration is swamped (compare (1c) with (1d)).

Another possible problem with concentration is that its relationship with profits might be nonlinear. Equation (1e) shows one possible nonlinear estimation. However, the hypothesis that concentration is linearly related to profitability can be rejected with only 90 percent confidence, against the alternative hypothesis of a second-degree polynomial relationship. Concentration expressed in semilogarithmic form also was estimated, but failed to be significant.

It should be mentioned here that similar nonlinear relationships between profitability and other independent variables (WMS, BCKVI, FWDVI, PEI, and MKTLNK) also were estimated, though not reported. In

44. Shepherd tried to mitigate this collinearity by introducing a structural variable, "Group," defined as the four-firm concentration ratio less market share. However, this variable did not perform much better and is not conceptually well-grounded.

45. See Bothwell and Keeler.

46. For the appropriate test procedure, see Jan Kmenta, Elements of Econometrics (Macmillan: New York, 1971), p. 452. In this case, the test statistic's value was 3.74 and F (1,18) = 4.41 at the .05 level. Hall and Weiss and Shepherd also found limited support for a quadratic concentration - profits function.
general, it would be difficult to reject the hypothesis of linearity in favor of either a second-degree polynomial or semilogarithmic hypothesis for these variables.

Overall, these results suggest that concentration is not a strong independent source of firm profitability and lend support to the hypothesis that the benefits of industry-wide market power are not shared equally among firms within an industry. To explore further this hypothesis and others, interactive models were estimated.

Interactive Models. Equation (1) assumes that elements of horizontal dominance have an additive impact on firm profits. But based on the discussion in Chapter III, there is good reason to believe that market share and concentration may interactively determine profitability. One way to test this possibility is to specify an interactive model. An appropriate model might then be:

\( RRRST = \beta_1 + \beta_2(WMS \cdot WCR) + \beta_3WCR \)

\( + \beta_4BCKVI + \beta_5FWDVI \)

\( + \beta_6PEI + \beta_7MKTLNK + \beta_8SCLE + \epsilon \)

which implies that

\( \frac{\partial RRRST}{\partial WMS} = \beta_2WCR \quad \text{and} \quad \frac{\partial RRRST}{\partial WCR} = \beta_2 \)
Hypothesizing that $\beta_2 > 0$ and $\beta_3 > 0$, this form of interaction suggests that market share's influence on profits increases with concentration. Similarly, not only may concentration per se influence firm performance, but the effect of concentration may be enhanced the greater is market share.

The results of estimating equation (2) appear in Table 3. All coefficients display the correct signs. The interaction term is significant at the .05 level and the hypothesis that the interaction term and WCR are jointly equal to zero can be rejected with 95 percent confidence. These findings are consistent with those of other studies. Note, however, that the fit of equation (2) is not as good as that of equation (1c).

The arguments presented in the preceding chapter also suggest, however, that market position and strategic position are interactive in their effect on firm profitability. In particular, the importance of market concentration may be better indicated in an interactive

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47. Note that both RSK and FI proved to be statistically insignificant and their exclusion improved the performance of the models presented. Accordingly, estimation with these two variables is not reported.

48. The test statistic's value was 4.3 and $F(2,19) = 3.52$ at the .05 level. See Kmenta, p. 456, for the appropriate tests for interactive models.

49. See, e.g., Gale.
TABLE 3
FIRM PROFITABILITY REGRESSION FOR THE INDUSTRY: MARKET POSITION INTERACTION MODEL

<table>
<thead>
<tr>
<th>Equation:</th>
<th>(2)</th>
</tr>
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<td>constant</td>
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</tr>
<tr>
<td>(1.341)</td>
<td></td>
</tr>
<tr>
<td>WMS * WCR</td>
<td>.003</td>
</tr>
<tr>
<td>(2.132)*</td>
<td></td>
</tr>
<tr>
<td>WCR</td>
<td>.061</td>
</tr>
<tr>
<td>(.898)</td>
<td></td>
</tr>
<tr>
<td>BCKVI</td>
<td>.013</td>
</tr>
<tr>
<td>(3.001)**</td>
<td></td>
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<tr>
<td>FWDVI</td>
<td>.122</td>
</tr>
<tr>
<td>(3.216)**</td>
<td></td>
</tr>
<tr>
<td>PEI</td>
<td>.036</td>
</tr>
<tr>
<td>(2.659)**</td>
<td></td>
</tr>
<tr>
<td>MKTLNK</td>
<td>.024</td>
</tr>
<tr>
<td>(2.091)*</td>
<td></td>
</tr>
<tr>
<td>SCLE</td>
<td>-.744</td>
</tr>
<tr>
<td>(2.577)**</td>
<td></td>
</tr>
</tbody>
</table>

\[ R^2 \] = .8695
n = 27

NOTE: Dependent variable is RRASST. t-statistics are given in parentheses. Equation is weighted to correct for heteroscedasticity. One and two stars denote statistical significance at the .05 and .01 levels (one-tailed), respectively. Mean of WCR is 42.99.
framework with those firm-specific elements of intraindustry structure. The model most reflective of this reasoning might then be:

\[
(3a) \quad \text{RRASST} = \beta_1 + \beta_2 \text{WMS} + \left[ \beta_3 \text{BCKVI} + \beta_4 \text{FWDVI} + \beta_5 \text{PEI} \right.
\]
\[
+ \beta_6 \text{MKTLNK} \cdot \text{WCR} + \beta_7 \text{SCLE} + \varepsilon
\]

which implies that

\[
\frac{\partial \text{RRASST}}{\partial x_i} = \beta_i \text{WCR} \quad \text{and}
\]

\[
\frac{\partial \text{RRASST}}{\partial \text{WCR}} = \sum_{i=3}^{6} \beta_i x_i \quad i=3,4,\ldots,6
\]

where \(x_3, x_4, \ldots\) refer to the variables BCKVI, FWDVI, and so on. An alternative to equation (3a) also can be specified, taking into account the possible interaction between market share and concentration:

\[
(3b) \quad \text{RRASST} = \beta_1 + \left[ \beta_2 \text{WMS} + \beta_3 \text{BCKVI} + \beta_4 \text{FWDVI} + \beta_5 \text{PEI} \right.
\]
\[
+ \beta_6 \text{MKTLNK} \cdot \text{WCR} + \beta_7 \text{SCLE} + \varepsilon
\]

Table 4 reports the results of estimating equations (3a) and (3b). In both models, the market position and strategic position coefficients all display the right sign; SCLE remains negative, but smaller (in absolute value). The interactions between concentration
TABLE 4
FIRM PROFITABILITY REGRESSIONS FOR THE INDUSTRY: MARKET POSITION-STRATEGIC POSITION INTERACTION MODELS

<table>
<thead>
<tr>
<th>Equation:</th>
<th>(3a)</th>
<th>(3b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMS</td>
<td>.133 (1.782)*</td>
<td>---</td>
</tr>
<tr>
<td>WMS • WCR</td>
<td>---</td>
<td>.002 (1.638)</td>
</tr>
<tr>
<td>BCKVI • WCR</td>
<td>.0003 (2.865)**</td>
<td>.0003 (2.711)**</td>
</tr>
<tr>
<td>FWDVI • WCR</td>
<td>.003 (3.158)**</td>
<td>.003 (3.112)**</td>
</tr>
<tr>
<td>PEI • WCR</td>
<td>.0007 (2.356)*</td>
<td>.0007 (2.212)*</td>
</tr>
<tr>
<td>MKTLNK • WCR</td>
<td>.0004 (1.821)*</td>
<td>.0004 (1.759)*</td>
</tr>
<tr>
<td>SCLE</td>
<td>-.620 (2.330)*</td>
<td>-.559 (2.161)*</td>
</tr>
</tbody>
</table>

\[
\hat{R}^2 = .8659 \quad .8630 \\
n = 27 \quad 27
\]

NOTE: Dependent variable is RRASST. t-statistics are given in parentheses. Equations are weighted to correct for heteroscedasticity. One and two stars denote statistical significance at the .05 and .01 levels (one-tailed), respectively. Mean of WCR is 42.99.
and multimeter linkages and product-extension integration are significant at the .05 level, while concentration's interaction with either measure of vertical integration is significant at the .01 level. Though market share alone is significant in equation (3a), interestingly, it fades when sharing the concentration interaction with other independent variables.

While (3a) provides a somewhat better fit than (3b) neither are as robust as (1c) or (2), their noninteractive counterparts. In order to test the relative merits of these models, I estimated two twelve-variable (less constant term) models: one which included both sets of variables comprising (3a) and (1c) and one which included both sets of variables comprising (3b) and (2). The regression results are not reported because severe multicollinearity renders the coefficients uninterpretable. The test results reject the null hypothesis that concentration interacting with strategic position variables add no explanatory power to (1c) at the .05 level, yet also reject the null hypothesis that concentration and strategic position variables entered additively do not enhance the explanatory power of (3a) at the .05 level. Similar results were obtained for (3b)

50. That is, one model was: \( RRAST = f(C, WMS, WCR, BCKVI, FWDVI, PEI, MKTLNK, SCLE, WCR \cdot \{BCKVI, FWDVI, PEI, MKTLNK\}) \) and the other was: \( RRAST = f(C, WMS \cdot WCR, WCR, BCKVI, FWDVI, PEI, MKTLNK, SCLE, WCR \cdot \{BCKVI, FWDVI, PEI, MKTLNK\}) \).
and (2). While, overall, (1c) and (2) may provide better fits, these test results imply that interactions between strategic and market position are also statistically important: that is, both sets of variables are important determinants of firm profitability.\(^5\)

To this point, I have examined the influence of vertical integration on profitability independent of total firm scale. But, as previously argued, it is likely that scale differences may work to the disadvantage of smaller vertically integrated firms, to the extent that there are aspects of vertical integration strategies subject to economies of scale at the firm level. The following model specifies the appropriate interaction between scale and vertical integration:

\[(4) \quad \text{RRASST} = \beta_1 + \beta_2 \text{WMS} + \beta_3 \text{WCR} + \beta_4 (\text{BCKVI} \cdot \text{SCLE}) + \beta_5 (\text{FWDVI} \cdot \text{SCLE}) + \beta_6 \text{PEI} + \beta_7 \text{MKTLNK} + \beta_8 \text{SCLE} + \epsilon\]

which implies that

\[51. \quad \text{The value of the test statistic rejecting the hypothesis that concentration interacting with strategic position variables add no explanatory power to (1c) was 3.37 and F(4,15) = 3.06; the test statistic rejecting the hypothesis that additively concentration and strategic position variables add no explanatory power to (3b) was 3.31 and F(5,15) = 2.90.}\]

\[52. \quad \text{Using a different structure-performance model at the industry level, Pugel obtained somewhat similar results following this procedure.}\]
\[ \partial R R A S S T / \partial B C K V I = \beta_4^{SCLE} \quad \text{and} \]

\[ \partial R R A S S T / \partial F W D V I = \beta_5^{SCLE} \quad \text{and} \]

\[ \partial R R A S S T / \partial S C L E = \beta_4^{B C K V I} + \beta_5^{F W D V I} + \beta_6. \]

The results of estimating equation (4) are presented in Table 5. Both interaction terms are positive and significant; scale remains negative and also significant. These results suggest that, on average, large scale vertically integrated firms have higher profits than firms equally vertically integrated but of smaller overall size. Thus, while large total firm scale independently contributes more to costs (and inefficiencies) than market power, it enables firms to realize any economies of scale at the firm level associated with vertical integration.

Models of Firm Performance within Strategic Groups. The theory of firm performance that I have advanced suggests that different elements of intraindustry structure provide mobility barriers and affect the prospects for collusion for firms belonging to different strategic groups within an industry. Thus, different structural models should account for the dispersion in firm performance across strategic groups.

To test this proposition the 27-firm panel was partitioned along the strategic dimension of backward vertical integration into two panels: one, comprised of the fourteen firms with an above-average degree of backward vertical integration (henceforth denoted the High-VI
TABLE 5
FIRM PROFITABILITY REGRESSION FOR THE INDUSTRY:
VERTICAL INTEGRATION-SCALE INTERACTION MODEL

<table>
<thead>
<tr>
<th>Equation:</th>
<th>(4)</th>
</tr>
</thead>
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<tr>
<td>constant</td>
<td>5.323</td>
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<tr>
<td></td>
<td>(1.568)</td>
</tr>
<tr>
<td>WMS</td>
<td>0.134</td>
</tr>
<tr>
<td></td>
<td>(1.676)</td>
</tr>
<tr>
<td>WCR</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>(1.091)</td>
</tr>
<tr>
<td>BCKVI · SCLE</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(2.511)*</td>
</tr>
<tr>
<td>FWDVI · SCLE</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>(2.564)**</td>
</tr>
<tr>
<td>PEI</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>(2.183)*</td>
</tr>
<tr>
<td>MKTLNK</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>(1.460)</td>
</tr>
<tr>
<td>SCLE</td>
<td>-0.934</td>
</tr>
<tr>
<td></td>
<td>(2.669)**</td>
</tr>
</tbody>
</table>

\[ \bar{R}^2 \] 0.8440
\[ n \] 27

NOTE: Dependent variable is RRASST. t-statistics are given in parentheses. Equation is weighted to correct for heteroscedasticity. One and two stars denote statistical significance at the .05 and .01 levels (one-tailed), respectively. Mean of SCLE is 7.20.
group), and the other comprised of the thirteen firms with below-average backward vertical integration (henceforth denoted the Low-VI group).  

Vertical integration is the key strategic dimension in petroleum and, historically, upstream integration has been the most critical determinant of economic success. (In addition, there was not a geographic boundary problem associated with obtaining data to measure BCKVI, as there was with FWDVI.) The presumption underlying this partition is that the firms in each group pursue the common strategy of (backward) vertical integration to roughly the same degree, but that even within groups firms assume different strategic positions along this dimension.

Ideally, it might have been preferable to partition the industry panel into a third strategic group -- comprised of firms with a medium degree of backward vertical integration -- which would act as a buffer zone between groups with high and low degrees of vertical integration. The proposition that the models should differ across strategic groups defined on the basis of backward vertical integration is equivalent to an interaction hypothesis (of backward vertical integration interacting with all independent variables). If these interaction effects are continuous rather than discrete, incorporating the medium group would probably result in a more precise statistical analysis. Unfortunately,

---

53. The mean of BCKVI is 82 for the 27-firm panel. The means of BCKVI for the Low-VI group and the High-VI group are 36 and 125, respectively.
the remaining degrees of freedom do not permit the formation of a third group. 54

Table 6 presents a strategic group comparison of average firm profitability and zero-order correlations between firm profitability and the independent variables. The mean profit rate for firms in the High-VI group is significantly greater than that of firms in the Low-VI group. This result supports the hypothesis that firms pursuing vertical integration extensively are systematically better insulated from rivalry by virtue of high mobility barriers. Interestingly, in defining strategic groups more on the basis of oligopolistic rather than strategic similarities, Porter did not find a statistically significant difference between average group profitability. 55

The difference in the pattern of simple correlation coefficients between strategic groups provides preliminary confirmation of the notion that different structural elements have different profitability consequences between strategic groups, though a more complete analysis is presented below. The most striking differences between groups are the profitability correlations with market share, vertical integration, multimarket linkages, and scale. And, within groups, there is also a

54. Gale also discusses this problem in his empirical analysis of oligopoly groups.

55. Porter, "The Structure Within Industries and Companies' Performance," p. 223. The contrast in these results may also be due to the fact that Porter's analysis focused on the group rather than the firm per se.
### TABLE 6
COMPARISONS OF AVERAGE PROFITABILITY AND FIRM PROFITABILITY CORRELATIONS: THE INDUSTRY AND STRATEGIC GROUPS

<table>
<thead>
<tr>
<th>Correlation with Firm Profit Rate</th>
<th>INDUSTRY (27-firm panel)</th>
<th>HIGH-VI GROUP (14-firm panel)</th>
<th>LOW-VI GROUP (13-firm panel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMS</td>
<td>.516</td>
<td>.636</td>
<td>.238</td>
</tr>
<tr>
<td>WCR</td>
<td>.575</td>
<td>.487</td>
<td>.495</td>
</tr>
<tr>
<td>BCKVI</td>
<td>.515</td>
<td>.212</td>
<td>.437</td>
</tr>
<tr>
<td>FWV1</td>
<td>.496</td>
<td>.336</td>
<td>.645</td>
</tr>
<tr>
<td>PEI</td>
<td>.043</td>
<td>-.243</td>
<td>.115</td>
</tr>
<tr>
<td>KMINK</td>
<td>.562</td>
<td>.667</td>
<td>.234</td>
</tr>
<tr>
<td>SCLE</td>
<td>.500</td>
<td>.552</td>
<td>.230</td>
</tr>
</tbody>
</table>

**NOTE:** Profit rate is rate of return on net total assets (RRASST). With n=27 a correlation coefficient of .32 is significant at the .05 level (one-tailed). At the same level, with n=14 the coefficient must be .46; and with n=13, .48.

* Significant at the .05 level (one-tailed).
greater difference in the relative importance of particular simple correlations than that revealed for the industry as a whole.

The pronounced differences in average firm profitability and the correlation coefficients between strategic groups are confirmed by multiple regression analysis. Table 7 presents the results of estimating the basic model for each strategic group and (for comparative purposes) repeats the results for the industry as a whole. The hypothesis that the two strategic group equations are equal can be rejected at the .01 level.\textsuperscript{56}

Taking the market position variables first, market share is consistently positive and significant. While concentration becomes a significant, positive, independent influence on firm profits within the Low-VI group, it remains insignificant for the High-VI group and with an incorrect sign. There is good reason to believe, however, that the poor performance of concentration in the High-VI model is caused by its extreme collinearity with market share in the sample ($r=.93$). Not

\textsuperscript{56} The value of the test statistic was 13.691 and $F(8,16) = 3.89$ at the .01 level. The test procedure is described in Kmenta, pp. 373-74. Note that while the industry equation required a heteroscedastic correction, the strategic equations did not. Therefore, the goodness of fit measures are not strictly comparable. Because the group equations pertain to firms within the same industry, there was a possibility that there might have been a strong correlation between residuals, thus creating the problem of seemingly unrelated regressions (see Kmenta, pp. 517-30). However, in every case, the correlation between residuals never surpassed .00002 and therefore, it is highly unlikely that this problem was present.
### Table 7

**Comparison of Firm Profitability Regressions for the Industry and Strategic Groups: Basic Model**

<table>
<thead>
<tr>
<th>Equation:</th>
<th>INDUSTRY</th>
<th>HIGH-VI GROUP</th>
<th>LOW-VI GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{constant} )</td>
<td>3.925</td>
<td>15.310</td>
<td>-4.681</td>
</tr>
<tr>
<td>( (1.294) )</td>
<td>( (2.612) )*</td>
<td>( (1.517) )</td>
<td></td>
</tr>
<tr>
<td>( \text{VMS} )</td>
<td>.171</td>
<td>.319</td>
<td>.517</td>
</tr>
<tr>
<td>( (2.277) )*</td>
<td>( (2.738) )*</td>
<td>( (3.042) )*</td>
<td></td>
</tr>
<tr>
<td>( \text{WCR} )</td>
<td>.075</td>
<td>-.122</td>
<td>.283</td>
</tr>
<tr>
<td>( (1.175) )</td>
<td>( (.674) )</td>
<td>( (4.224) )**</td>
<td></td>
</tr>
<tr>
<td>( \text{BCKVI} )</td>
<td>.014</td>
<td>.014 [.237]</td>
<td>.027 [.159]</td>
</tr>
<tr>
<td>( (3.142) )**</td>
<td>( (2.183) )*</td>
<td>( (3.134) )*</td>
<td></td>
</tr>
<tr>
<td>( \text{FDVI} )</td>
<td>.122</td>
<td>.103 [.215]</td>
<td>.131 [.315]</td>
</tr>
<tr>
<td>( (3.255) )**</td>
<td>( (2.061) )*</td>
<td>( (3.633) )**</td>
<td></td>
</tr>
<tr>
<td>( \text{PEI} )</td>
<td>.038</td>
<td>.044 [.117]</td>
<td>.045 [.063]</td>
</tr>
<tr>
<td>( (2.800) )**</td>
<td>( (2.632) )*</td>
<td>( (1.347) )</td>
<td></td>
</tr>
<tr>
<td>( \text{BDI} )</td>
<td>.023</td>
<td>.036 [.347]</td>
<td>-.011 [-.068]</td>
</tr>
<tr>
<td>( (2.064) )*</td>
<td>( (2.931) )*</td>
<td>( (0.506) )</td>
<td></td>
</tr>
<tr>
<td>( \text{SCL})</td>
<td>-.801</td>
<td>-.1297</td>
<td>-.831</td>
</tr>
<tr>
<td>( (2.726) )**</td>
<td>( (1.767) )</td>
<td>( (2.034) )*</td>
<td></td>
</tr>
</tbody>
</table>

| \( R^2 \) | .8730 | .6584 | .8001 |
| \( n \) | 27 | 14 | 13 |

**Note:** Dependent variable is \( \text{BASST} \). \( t \)-statistics are given in parentheses below coefficients. Bracketed numbers are point elasticities calculated at the mean of the independent variable.

Equation (1c) is weighted to correct for heteroscedasticity; equations (H1c) and (L1c) did not require heteroscedastic correction. One and two stars denote statistical significance at the .05 and .01 levels (one-tailed), respectively.
surprisingly, other studies have yielded similar results.\textsuperscript{57} It is important to realize, however, that this high degree of multicollinearity is a feature of the sample and not of the population, and little can be done to remedy the situation. (Below, group models which take into account the interaction of concentration with other independent variables are estimated.) In any event, these results do suggest that firms within industries may be members of strong oligopoly groups but not necessarily members of dominant strategic groups.

The most interesting finding here is the differences in the strategic position variables: all are positive and significant for the High-VI group, but only backward and forward vertical integration are significant for the Low-VI group. The notion that different elements of intraindustry structure provide mobility barriers and heighten the prospects of collusion for firms situated in different strategic groups within an industry thus receives strong support.

For instance, while highly vertically integrated firms are more prone to react to each others' actions through multimarket linkages and face lower mobility costs as a result of these parallel market-extension integration patterns in refining, their less vertically integrated counterparts in the industry appear not to derive

\textsuperscript{57} See, e.g., William S. Comanor and Thomas A. Wilson, "Advertising, Market Structure, and Performance," \textit{Review of Economics and Statistics} 49 (November 1967): 423-40. Porter also found a negative concentration-profits relationship where two cases were actually statistically significant.
market power by pursuing that strategy; in fact, MXTNK has a negative sign for the Low-VI group.

Similarly, product-extension integration is a significant determinant of firm profitability within the High-VI group, but insignificant in the Low-VI group.

While both backward and forward vertical integration are significant determinants of firm profitability within each strategic group, across groups there is a noticeable difference in how the two vertical integration strategies influence performance. Such differences are best revealed by calculating the elasticity at the mean of the independent variable; these elasticities appear in brackets to the right of all strategic position coefficients. Because it was impossible to form a third group to act as a buffer zone between the High-VI and Low-VI groups, these point elasticities better depict standardized differences in the strategic position of the typical firm within each group; the coefficients per se may be more sensitive to the imperfect classification of an outlying firm to either group. Interestingly, the results imply that backward vertical integration has a greater influence on profits in the High-VI group than in the Low-VI group. And, forward vertical integration is more important for firms in the Low-VI group than those in the High-VI group.

These findings suggest two observations. First, while retailing has traditionally been considered a low profit activity across
industries, presumably because expenses consume a large fraction of gross income and market power problems rarely exist at this stage, treating retail marketing within a multimarket framework reveals that, at least within this industry, forward integration can indeed heighten profits. (This point applies to the industry model as well as both group models.)

Second, the fact that backward integration appears to be more profitable for the High-VI group and that forward integration is more significant for the Low-VI group provides support for the notion that firms variously positioned within an industry may tend to specialize in particular strategies. In this case, the findings are consistent with other empirical evidence. For example, integrated refiners historically have been both the suppliers of much of the gasoline sold by their less integrated counterparts and their competitors. Yet, the highly integrated firms tended to operate low volume outlets in urban centers which generated high margins. In time, however, the less integrated firms began to market at high volume stations in the suburban areas, eroding the profitability of the integrated firms.


marketing operations. 60

Finally, to complete the discussion of the results presented in Table 7, note that while the scale coefficient is no longer significant, but still negative, for the High-VI group, it is both significant and negative for the Low-VI group. Apparently, while there are not appreciable economies of scale for firms in the first group, in the latter group scale increases, on balance, are inefficient.

Estimation of the interactive models also confirms the hypothesis that different structural elements determine the profitability of firms situated in different strategic groups. Table 8 reports these results. In general, there is strong support for the notion that market position and strategic position interactively influence profitability for the High-VI group, but it fades significantly for firms belonging to the Low-VI group. Like the industry as a whole, firms in each group that operate in concentrated markets and attain high market shares have higher profits when concentration interacts with share alone. Entered additively, scale remains negative in all cases. However, while the scale-vertical integration interaction remains strong in the Low-VI group it becomes insignificant for the highly vertically integrated firms. Thus, for less vertically integrated firms, the larger is total firm scale the

-------------------
60. Mobility barriers for marketing are probably lower than those for other stages in the vertical chain. See Fred C. Allvine and James C. Patterson, *Competition, Ltd.: The Marketing of Gasoline* (Bloomington: Indiana University Press, 1972).
<table>
<thead>
<tr>
<th>Equation:</th>
<th>(H2)</th>
<th>(H3a)</th>
<th>(H3b)</th>
<th>(H4)</th>
<th>(L2)</th>
<th>(L3a)</th>
<th>(L3b)</th>
<th>(L4)</th>
</tr>
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<tbody>
<tr>
<td><strong>HIGH-VI GROUP</strong></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.715)*</td>
<td>(3.419)**</td>
<td>(3.385)**</td>
<td>(2.886)*</td>
<td>(1.329)</td>
<td>(3.139)*</td>
<td>(3.297)**</td>
<td>(1.119)*</td>
</tr>
<tr>
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<td>0.211</td>
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<td></td>
<td>(1.849)</td>
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</tr>
<tr>
<td>WNS • WCR</td>
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<td></td>
<td>0.006</td>
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<td>0.017</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(2.860)*</td>
<td></td>
<td></td>
<td></td>
<td>(3.066)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WCR</td>
<td>-1.152</td>
<td></td>
<td></td>
<td></td>
<td>0.259</td>
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<td>(1.623)</td>
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</tr>
<tr>
<td>BCKVI</td>
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<td></td>
<td>0.019</td>
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<td></td>
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| NOTE: | Depend variable is BRASST. t-statistics are given in parentheses. Equations did not require heteroscedastic correction. One and two stars denote statistical significance at the .05 and .01 levels (one-tailed), respectively. Means of WCR for HIGH-VI group and LOW-VI group are 44.47 and 41.40, respectively; means of SCLE are 8.31 and 6.01, respectively.

* Denotes that all strategic position variables are multiplied by concentration variable.
greater will a given increase in vertical integration result in higher profits. But, interestingly, for firms already substantially integrated, further increases in vertical integration need not be accompanied by large total firm scale to heighten profits, though it should be pointed out that both scale-interaction terms for the High-VI group are just barely insignificant at the .05 level.

Summary of Results. Overall, the empirical results strongly support the theory that firm performance is determined by elements of intraindustry structure and that, indeed, multimarket activity constitutes one such element, casting doubt on the "horizontal dominance hypothesis."

The importance of seller concentration (primarily through interactive effects with firm market share and strategic position) and market share is affirmed, not only for the very largest firms -- as previous structure-performance studies have shown -- but for a greater size distribution of firms for which, in this particular industry, the assumption of constant-cost conditions may not be seriously damaged.\textsuperscript{61} And total firm scale was found, on balance, to have a dampening effect on performance.

Risk and foreign investment were insignificant influences on profits, despite a number of attempts using different measures.

The rate of return on net total assets appeared to be a more

\textsuperscript{61} I discuss this issue more fully in the next chapter.
sensitive measure of intraindustry profitability differences than the rate of return on stockholders' equity, though the use of the latter would not substantially change these conclusions.

Altogether, the levels of the corrected coefficient of determination imply that the regressions explain a large portion of the dispersion of profit rates among firms in the sample, particularly by the standards for cross-section analysis.

In the final chapter the policy issues raised by these findings are discussed, as well as the implications for future research.
CHAPTER V

IMPLICATIONS FOR PUBLIC POLICY AND FUTURE RESEARCH

V.A. Introduction

The empirical results suggest a number of implications for antitrust policy, which are discussed in the next section. Section V.C draws inferences for future research.

V.E. Implications for Antitrust Policy

The theoretical framework and statistical results presented in the preceding pages are offered as an attempt to close a gap in industrial organization analysis, as recognized by the new Assistant Attorney General for Antitrust:

In my view there is no such thing as a vertical "problem"...If there is any major weakness in antitrust doctrine and analysis as it has been applied in recent years, it is the tendency to focus on general categories of vertical arrangements and behavior without any careful analysis of their horizontal impacts, if any.1

More generally, this study suggests that extensive firm integration, both vertical and conglomerate forms, should properly be the focus of

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antitrust analysis even when horizontal conditions within individual markets might not warrant such an examination. Moreover, because market power is likely to be influenced by subtle characteristics of the industrial environment, such as parallel patterns of integration among firms within an industry, the findings imply that the conventional approach to antitrust analysis -- based on simple relationships between structure and performance -- may yield misleading judgments as to the actual state of competition between firms. Rather than being only concerned about which industries are good performers and which are bad performers, antitrust authorities need to focus on the differences within industries.

The principle objective of antitrust analysis is to design policies that both promote competitive and limit anticompetitive elements of industrial structure and firm conduct so as to maximize allocative efficiency. The central issue then is to identify those structural elements (and conduct) that permit firms to realize pecuniary gains in input or output (distribution) markets (that is, market power) over and above any true technical economies associated with such elements. The optimal policy is one that curbs these pecuniary economies (perhaps through structural changes, behavior limits, or tax incentives) yet preserves any true technical efficiencies.

The results of this study suggest that firms in strong market positions (in particular, those with high market shares) and/or strong strategic positions (those that are extensively integrated) are likely
to have higher profit rates than other firms within an industry — in this case the petroleum refining industry. To what extent are the strongly positioned firms in this industry more technically efficient than their less profitable counterparts?

To be sure, high market shares (and high seller concentration) partly reflect greater efficiency, but there is good reason to believe, for this sample at least, that above-normal profits associated with substantial horizontal dominance cannot be explained on efficiency grounds alone. The usual expectation is that firms that are more efficient are likely to be able to increase their share of the market over time. However, from 1954 to 1972 (the latest date for which consistent data are available), despite reasonably stable prices and a twofold increase in the size of the domestic refining market, the shares of the top 4, the top 8, and the top 20 refiners were virtually unchanged. Evidently, the smaller share refiners, able to grow at the same rate as the market, were at least as efficient as the large share firms.

Two possible sources of true scale efficiency that may, in part, contribute to the high profits of dominant share firms in this study are economies of scale at the plant and multiplant levels in refining.

Based on the state of technology during the 1960s and early

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1970s, estimates of minimum efficient scale (MES) for refining plants range from 100 thousand barrels per day (tb/d) to 200 tb/d capacity, with most estimates placed at the 150 tb/d level -- which would account for 1.2 percent of domestic capacity. But generally unit costs do not appear to rise very sharply until plant scale drops considerably below the lowest of these MES estimates. For instance, liberally taking the maximum of these figures as the appropriate MES, Scherer estimated that a refinery of one third MES would face, at most, a cost disadvantage of less than 5 percent. In fact, an examination of the size distribution of domestic refineries reveals that relatively few have capacities above MES: a substantial portion of the plants have capacities ranging from 20 to 50 tb/d and have long survived (and continue to survive) even though they are theoretically inefficient. Indeed, 51 of the 70 domestic refineries operated by the eight largest firms in 1969 had capacities of only 30 tb/d or less.

Two factors can explain why so many sub-MES refineries may be economic. First, optimal plant scale depends not only on unit production costs, but on unit materials costs as well. Because


4. Scherer at al., *The Economics of Multi-Plant Operation*.

materials costs are usually sensitive to plant location and transportation costs (e.g., proximity to pipelines or water transport facilities), the higher operating costs of small refineries serving remote limited markets may be offset by the transportation costs of shipping in products from outside the area. Secondly, and this point would apply mostly to the established large firms, if the capital costs of smaller plants are fully depreciated, production costs may be less than the combined production and capital costs of newer, more efficient larger plants. 6

What about technical efficiency at the multiplant or company-wide level? The most thorough research on this issue has been performed by Scherer. 7 His study suggested that firms that own two to three MES refineries might experience, overall, only a slight unit cost advantage (roughly 1 to 5 percent) over single plant firms. But this estimate was based on the assumption that the multiplant firm enjoyed all of the benefits of multiplant operation; that is, "that the multiplant firm is in fact able to wring out of its opportunities all of the advantages that might be there." 8 In this sense then, these advantages represent an upper limit to any multiplant economies of

6. See Measday.
7. Scherer et al.
scale. Yet, as Scherer noted, "[the realization of these economies] does not always happen. Sometimes firms behave sluggishly and do not take advantage of all their opportunities." Indeed, he argued that multiplant scale in refining could prove to be disadvantageous if such operations are extensive and lead to control loss and managerial inefficiencies. The statistical findings of the present investigation, in suggesting that high market share and seller concentration add to profitability even after controlling for the effects of increases in multiplant or total firm scale and that, in fact, increases in company-wide scale tend to dampen performance, are consistent with Scherer's research: if there are economies of scale at the firm level in refining they are probably quite modest.

Altogether the above analysis suggests that technical economies of scale in refining, both at the plant and multiplant levels, are probably not the main elements contributing to the high profits of firms with substantial horizontal dominance. (This conclusion is consistent with that of a recent study by Shepherd in which the efficiency basis in economies of scale for high market shares of firms from a variety of industries is examined more directly.) In short, this argument implies that scale economies do not pose an insurmountable barrier to entry for new competitors in refining.

9. Ibid.

Rather, as I have posited, the primary sources of barriers to new competition in this industry are the absolute cost advantages and capital requirements associated with access to crude oil and distribution facilities through vertical integration, and the absolute cost advantages and capital requirements associated with conglomerate forms of integration.

Turning now to the high profits earned by firms in dominant strategic positions, to what extent can such profits be explained by increased technical efficiency associated with extensive integration? While it is true that there may be real efficiency gains associated with a modest degree of integration — particularly vertical, but less so with conglomerate integration — it is unlikely that such economies can justify the extent of integration pursued by some firms in this industry.

Consider the case of vertical integration. If strategies of extensive vertical integration lead to increases in efficiency, presumably less vertically integrated ("inefficient") refiners would want to replicate such strategies. But, the main lesson from the industry's modern history is that even in the long run, they are unable to do so: something is preventing strategic replication; indeed, that is what the existence of mobility barriers provided by the pursuit of particular competitive strategies implies. (Similarly, the hypothesis that highly integrated firms are more profitable because they are luckier than the rest may explain transitory differences in performance but cannot account for systematic differences. Presumably nothing
prevents firms that are disadvantaged only by lack of luck from replicating, over time, successful products or processes.)\textsuperscript{11}

Moreover, unlike steel, where technological interdependencies usually exist between stages of production, or perhaps automobile production, where the provision of components and materials may involve compelling scale economies, vertical integration in petroleum rarely involves an intracorporate "continuous flow" from wellhead to retail pump. For example, though little systematic data are available, it is known that possibly only a small percent of the crude produced by a vertically integrated firm actually moves through its own refineries.\textsuperscript{12} That firms capable of supplying themselves with inputs (or distributing their outputs) regularly choose instead to enter the market for their inputs (or outputs) suggests that there is little inherent technical or cost necessity for vertical integration in this industry, and if there are efficiency reasons associated with such integration there is little assurance that all of the reduced costs will be passed on to consumers. In fact, this evidence implies that the type of transaction cost advantages that Williamson and others attribute to vertical integration are not apparent in petroleum. As Duchesneau has pointed out in discussing the rationale for backward


vertical integration:

the product is relatively simple and standardized and requires little highly specialized investment...the information costs of using markets to obtain crude oil, rather than to rely upon backward integration do not appear excessive.

Finally, if there are strong efficiency motives behind vertical integration in petroleum, one is hard put to explain the apparent ability to survive of so many non-integrated firms side-by-side with integrated firms in each vertical market.

Not surprisingly, the consensus among serious students of petroleum industrial organization is that, at best, there are only slight technical efficiencies to be gained through vertical integration. Thus Duchesneau concluded that, "efficiency arguments in favor of extensive vertical integration in oil do not appear overwhelming." But perhaps the most candid assessment of the issue has been made by Adelman:

The industry's contention, that vertical integration helps efficiency, is unfounded. Common ownership of these activities, by one company, neither saves money nor costs any. (There are bound to be some exceptions to the rule; relatively, they are unimportant.) Most companies became integrated long ago for reasons that are now history. They have stayed integrated because there is no reason to change.


If, as I have argued, the high profits of firms with substantial horizontal dominance and/or extensive integration cannot be completely attributed to superior technical efficiency, what inferences can be drawn regarding an appropriate antitrust policy?

On the one hand, if there were indications that such firms, particularly those with large scale operations, might continue the retrenchment that some began in the early 1970s (as pointed out in the previous chapter) or become increasingly susceptible to intraindusry (or extraindusry) rivalry, then the current relaxed policy might be on the right track. Unfortunately, this trend has not continued; if anything, it has reversed in recent years. Consider these three factors. First, although it is true that the OPEC initiatives have altered the strategic and market positions of many of the dominant firms, the extent to which these changes have had more than a nominal impact on these firms' ability to exercise leverage over weaker rivals within the industry remains unclear. For example, nonintegrated refiners still must rely on crude purchases from integrated firms to the extent that they don't enter the spot market and are unable to enter into longterm supply contracts directly with the producer nations.

Secondly, product-extension integration has increased dramatically, with a number of dominant refiners acquiring coal and mineral companies as well as firms specializing in future alternative energy sources. While there is a growing consensus that such investments may represent an inefficient use of scarce capital resources, what is perhaps even more troubling from the perspective of this study are the resulting parallel patterns of (product-extension) integration among firms that are also highly vertically integrated.\(^{17}\)

And finally, through various acquisitions, there has been, if anything, a recent increase in the number of plants operated by large scale firms in dominant strategic and market positions. Yet although many of these firms now operate large systems of refineries, some of the plants are the least efficient in the industry and cannot process the high sulfur, heavy foreign crudes that increasingly are dominating the world market.\(^{18}\) In contrast, many of the units operated by their smaller (though still large by industry standards) less-integrated counterparts are modern, constructed utilizing the latest technology and engineering advances, and upgraded regularly through new process innovations.\(^{19}\)


If this analysis is correct, then an appropriate focus of antitrust policy in petroleum should be on ways to reduce extensive vertical, conglomerate, and parallel integration as well as substantial horizontal dominance. Though presumably the elimination of horizontal dominance unjustified by technical economies in any industry is an objective shared by all antitrust analysts, this issue has been overlooked in studies of competition in petroleum by all but a few observers. Yet inasmuch as antitrust policy is relatively familiar with limiting horizontal market power — in this case by reducing extensive multirefinery ownership — the remaining discussion focuses on the policy implications toward integration; needless to say, however, the most effective policy design should take the problems associated with each dimension into account.

Because a separate study would be necessary to analyze fully both the efficacy and feasibility of various proposals that might be devised to reduce extensive integration in petroleum, here I only briefly outline a policy which is likely to be the most effective. Specifically, the policy would have as one of its components the limitation of backward vertical integration of all refiners —

20. Notable exceptions are Blair, The Control of Oil and Scherer's testimony in Hearings before the Senate Subcommittee on Antitrust and Monopoly on S. 2387.

regardless of the extent of their horizontal positions, but generally
of the total scale commensurate with that covered in this study — to a
level that would force them to enter the market for a significant
portion of their crude requirements. By taking a sizable volume of
crude out of their integrated systems and by forcing sales on an open
market, such a policy will tend to increase competition between the
various firms at the production and refining levels, make nonintegrated
refiners far more vigorous competitors, and go a long way towards the
creation of a real crude market.\(^{22}\) In Congressional testimony, Scherer
has advocated a similar position, suggesting, in fact, 35 percent crude
self-sufficiency as a benchmark, though presumably this figure
represents only an approximation.\(^{23}\) Nonetheless, in keeping with the
notion that there may be some true efficiencies (albeit slight ones)

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\(^{22}\) The role of OPEC, of course, complicates matters somewhat. The producer nations historically have been reluctant to supply crude to firms other than the international majors, though increasingly the business press has reported the signing of supply contracts between individual nations and smaller firms. (See, e.g., "The Oil War," Washington Post, October 3, 1980, p. B1.) In any event, at present most OPEC crude is still obtained by a small group of integrated firms who are in stronger positions to bargain not just for preferred crude access, but for other arrangements with OPEC (e.g., access to refined products) which keeps the vast bulk of crude in the firms' integrated channels.

Though a corresponding policy towards forward vertical integration might also be proposed, I focus on backward integration since historically there have been more serious competitive problems at the upstream level of production in petroleum.

\(^{23}\) Scherer, Hearings before the Senate Subcommittee on Antitrust and Monopoly. Scherer's proposal appeared to differ from the one suggested here in that he seemed to be focusing only on the very largest firms.
associated with a modest degree of vertical integration in petroleum, it would seem unwise to require complete (backward) vertical divestiture.24

The second policy component would be a restriction of further product-extension acquisitions by petroleum firms already substantially integrated, unless it can be demonstrated that such mergers will increase efficiency. While, in general, an outright ban on conglomerate mergers may eliminate an important source of potential competition in the "market for corporate control" that keeps would-be targets x-efficient, it is unlikely that banning a relatively small group of firms from one industry from participating in this "market" will be deleterious in this respect. Established extensive product-extension integration by petroleum firms should also meet the same criteria; otherwise conglomerate restructuring should be seriously considered. Overall, the burden of proof for product-extension integration must rest squarely with the firms rather than the authorities.25

Finally, a correct policy would be one that significantly

24. Complete vertical divestiture was the intent of S. 2387, where the eighteen largest petroleum firms would have been precluded from operating in more than one vertical stage; presumably each of the affected firms would be given the opportunity to choose which stage to specialize in. However, absent a corresponding horizontal policy, this proposal possibly could lead to an increase in horizontal dominance in particular stages.

25. Product-extension integration through internal expansion is not questioned here.
reduces parallel patterns of integration -- whether in the context of vertical, product-extension, or market-extension integration -- particularly among extensively integrated firms. Though it may appear that such a policy is easier to discuss theoretically than to actually carry out, with foresight this objective can be achieved simultaneously with the implementation of the other components. For instance, the reduction in multirefinery ownership can be devised in such a way as to limit parallel market-extension integration in refining. Similarly, the policy toward product-extension integration could be designed to accomplish a reduction in parallel patterns of integration in that context.

Because this policy proposal suggests possible divestiture the issue of the feasibility of requiring substantial divestiture needs to be considered. Perhaps the most compelling evidence that vertical divestiture is feasible is supplied by the companies themselves in testimony submitted to Congress about statements made to other forums. Thus, for example, in its testimony before the Wisconsin Tax Appeals Commission, Exxon argued that:

... none of [Exxon's] functional departments are integral parts of a unitary business composed of all functions combined; rather it [Exxon] will show that each function is independent and not unitary to, or an integral part of, any other function.

Again, before the South Carolina Tax Commission, Exxon stated:

Each of these functions is managed and accounted for on a functional operating basis. Each is a segment of Exxon's total corporate enterprise, but each has its own accounting, budgeting and forecasting, its own management and staff, its own profit center, its own investment center, its own physical facilities, etc. The profit or loss of each function is separately and accurately computed.27

The other extensively integrated firms similarly are organized on a regional and/or functional basis. For example, in 1975 Gulf reorganized its corporate structure into a group of worldwide functional subsidiaries, among them an extractive industries company (primarily oil production), a refining and marketing company, a transportation company, and so on.28 Thus, for the most part, the firms already have accomplished technical divestiture autonomously. Financial divestiture "would simply [involve] a further decentralization that would break the umbilical cord completely to the corporate headquarters."29

Furthermore, given the historical experience of corporate divestiture in the U. S., it is unlikely that the feasibility of implementing such a policy is beyond our reach. Indeed, as Scherer remarked:

"We split Standard Oil of New Jersey into more than 30 pieces in 1911, and the world did not come to an end. The Public Utility Holding Company Act somehow unscrambled"

27. Ibid.

28. See, e.g., Measday.

29. Scherer's testimony, Hearings before the Senate Subcommittee on Antitrust and Monopoly.
some very complex corporate structures. When Du Pont was required to divest its interest in General Motors, there was [sic] dire predictions that the stock market would collapse. Nobody who has analyzed this has been able to find a perceptible effect. I suspect that good investment bankers would find a way of reorganizing the financial aspects of the companies without a great deal of difficulty. And, I suspect, at considerable profit to themselves.

Of course, the criteria upon which to judge the benefits and costs of the proposed policy might incorporate other dimensions of economic efficiency, for example, the effects on dynamic efficiency. But there is evidence to suggest that while high profits earned by petroleum firms -- and other firms in general -- may mean greater spending on research and development per se, competitive pressures may bring about more productive R&D spending. And ultimately, judging the benefits and the costs may go beyond economic criteria, involving political and social considerations as well.

These policy conclusions require two qualifications. First, as frequently pointed out in the previous chapter, the data used in the empirical analysis are not ideal. Hence, some of the measures constructed are imperfect and may only approximate reality. But at the

30. Ibid.

present time they are probably the best available. There is, of course, consolation in knowing that many of this study's findings are consistent with previous structure-performance investigations using different data sources for different industries and for different time periods. Consequently, the results clearly place the burden of proof on those who argue that integration per se does not affect long run profitability.

The other qualification relates to the industry's current condition. First, with the recent deregulation of the industry it is likely that without further special provisions many very small refiners will go out of business in the short run. Since almost all of these firms are considerably below optimal scale and generally inefficient, having entered the domestic market in the late 1970s and surviving largely on subsidies stemming from the crude oil entitlements program and its attendant regulations, this expected adjustment in the composition of the industry is not unwarranted. However, in the long run, if the decline in the demand for petroleum products continues its

32. For instance, the distribution channels for refined products are quite complicated, yet the availability of data restricted this study to motor gasoline. Similarly, data were unavailable on a systematic basis for the transportation sector and crude reserves, and thus these factors could not be included in the analysis, even though they are important.

present trend, the potential for substantial excess capacity in domestic refineries will increase. Depending on how the various groups of firms (i.e., integrated vs. nonintegrated) respond to this problem and thus what the equilibrium conditions are, the policy initiatives that I have outlined may require some modification. Nevertheless, because this study's findings relate to a time period also relatively free from government regulations the conclusions are, in general, relevant to the current situation.

V. C. Implications for Future Research

Within key sectors of the economy other than petroleum, pronounced differences in integration strategies exist between firms, especially in the steel, automobile, and chemical industries. The framework that has been developed is general enough that it may be applied to an analysis of performance differences among firms in these and other industries.

Previous attempts to measure integration, particularly vertical integration, have been plagued by serious difficulties (as pointed out in chapter IV). While the measures of vertical integration that I employ are not totally free from problems (also discussed above), because they are intuitively more meaningful and probably more precise they are an improvement over financial measures. It is true, of

course, that physical measures of vertical integration are of limited use for interindustry comparisons, and that the inputs and outputs in petroleum are relatively simple and homogeneous thus making the calculation of physical indexes quite practicable. But it is not intuitively clear that comparisons between firms in disparate industries is the most meaningful way to assess the competitive impacts of vertical integration. Nevertheless, physical measures of vertical integration probably can be refined further and subjected to a more systematic comparison with financial measures.

Further attention also should be directed towards analyzing the extent to which intraindustry differences in accounting practices systematically affect reported performance differences, even though such practices presumably are more uniform within industries than between industries.

Finally, insofar as elements of industrial structure interactively influence market power -- a notion supported by this analysis as well as others -- such interactive effects should continue to be the focus of theoretical and empirical structure-performance studies.
APPENDIX

DESCRIPTION OF DATA SOURCES

This appendix briefly describes the sources of the data employed in the empirical analysis. Five types of sources were used: company financial accounts; official government documents and publications; reports published by trade associations; business directories and periodicals; and reports issued by large investment services. In general, it was possible to obtain a consistent data set for each variable. However, in the very few cases where the data were either inconsistent or incomplete, estimates were generally made on the basis of consultations with the companies.

All financial data used to construct RRASST, RRSTCK, and SCLE were taken from Compustat data files for 1970 through 1973 and averaged over that four year period. Compustat provides annual balance sheet and income statement information on tape compiled directly from company financial accounts by Standard and Poor’s Corporation. RSK was obtained from estimated “beta coefficients” in the 1972 Value Line investment survey.

Data employed in the construction of PEI and FI were obtained from company annual reports, statistical supplements, and 10-K forms filed with the U. S. Securities and Exchange Commission and averaged, in most cases, over the 1970-1973 period; in a few cases the available data did not permit the calculation of an average over the full four year period.
FWDVI, calculated for 1972, is based on information provided in Table 2-2 in the U. S. Department of Energy Report, The State of Competition in Gasoline Marketing.

BCKVI was constructed from data available in company annual reports, statistical supplements, and 10-Ks. In all but a few cases the data permitted the calculation of a four year average for the 1970-1973 period.

A number of different sources were used to construct WMS and WCR. Market shares and concentration in crude oil production were estimated using the U. S. Department of Energy report Technical Analysis of the International Oil Market, the American Petroleum Institute document, "Market Shares and Individual Company Data for U. S. Energy Markets: 1950-1978," and company annual reports. For retail marketing, market shares and concentration were calculated from the annual Lundberg Survey published in the 1972 National Petroleum News Factbook Issue. The data used to determine the nineteen major international refining markets -- in order to construct MKTLNK -- and the data employed in the estimation of market shares and concentration in refining were obtained from: "Report on Worldwide Refining" (Oil & Gas Journal); "U. S. Refining Capacity" (U. S. Refining Capacity (National Petroleum Refiners Association); Trends in Refinery Capacity and Utilization: Petroleum Refineries in the U. S. and Foreign Refinery Exporting Centers (U. S. Department of Energy); World Oil Refineries and Major Petroleum Refining Centers for Export (U. S. Central Intelligence Agency); Oil and Gas International Yearbook
In addition, various geographic editions of *Who Owns Whom* were consulted to ascertain refining company ownership. Data on patterns of foreign trade in refined products were taken from *Quarterly Oil Statistics* (O.E.C.D.). Volumetric weights were estimated from the above sources as well as company annual reports and statistical supplements.
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