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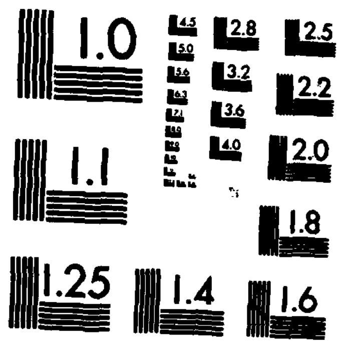

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THE RELATIVE IMPORTANCE OF MARKET POWER AND EFFICIENCY TO PROFITABILITY IN THE DEFENSE SECTOR: A FIRM BASED ANALYSIS

THESIS

Charles E. Schmeling
Captain USAF

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THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Operations Research

Charles E. Schmeling, B.S.
Capt USAF

December 1983

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED

1b. RESTRICTIVE MARKINGS:

2a. SECURITY CLASSIFICATION AUTHORITY:

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE:

3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release, distribution unlimited

4. PERFORMING ORGANIZATION REPORT NUMBER(S): AFIT/GOR/OS/83D-10

5. MONITORING ORGANIZATION REPORT NUMBER(S):

6a. NAME OF PERFORMING ORGANIZATION: School of Engineering

6b. OFFICE SYMBOL *(If applicable)*: AFIT/ENS

7a. NAME OF MONITORING ORGANIZATION:

6c. ADDRESS *(City, State and ZIP Code)*:

7b. ADDRESS *(City, State and ZIP Code)*:

8a. NAME OF FUNDING/SPONSORING ORGANIZATION:

8b. OFFICE SYMBOL *(If applicable)*:

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER:

8c. ADDRESS *(City, State and ZIP Code)*:

10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.

11. TITLE *(Include Security Classification)*: See Box 19

12. PERSONAL AUTHOR(S): Charles E. Schmelling, B.S., Captain, USAF

13a. TYPE OF REPORT: MS Thesis

13b. TIME COVERED: FROM ______ TO ______

14. DATE OF REPORT *(Yr., Mo., Day)*: 1983 December

15. PAGE COUNT: 168

16. SUPPLEMENTARY NOTATION:

Approved for public release: IAW AFR 190-17.
LYNN E. WOLAVER
Dean for Research and Professional Development
Air Force Institute of Technology (ATC)
Wright-Patterson AFB OH 45433

17. COSATI CODES

FIELD	GROUP	SUB. GR.
15	03	

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*:
Industrial Organization, Market Power, Efficiency, Structure-Performance Relationships, Defense Industry

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)* next page

Title: THE RELATIVE IMPORTANCE OF MARKET POWER AND EFFICIENCY TO PROFITABILITY IN THE DEFENSE SECTOR: A FIRM BASED ANALYSIS

Thesis Chairman: Dr. Robert F. Allen, PhD

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐

21. ABSTRACT SECURITY CLASSIFICATION: UNCLASSIFIED

22a. NAME OF RESPONSIBLE INDIVIDUAL: Robert F. Allen, PhD

22b. TELEPHONE NUMBER *(Include Area Code)*: 513-255-3362

22c. OFFICE SYMBOL: AFIT/ENS

DD FORM 1473, 83 APR — EDITION OF 1 JAN 73 IS OBSOLETE.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

Abstract

This study investigates and compares the factors that influence profitability in American manufacturing and in the defense industry. In particular, the relationships among market power, efficiency, and profits are explored for each group. In each case the unit of observation is the firm. Data is collected for a random sample of manufacturing firms, a set of primary defense firms from the top five defense oriented industries, and a set of defense related firms from the top eleven defense oriented industries. The basic model states that profits are a function of market power, efficiency, growth, product differentiation, geographic dispersion, research and development expense, and firm size. Market power is measured by the four-firm concentration ratio and the number of firms in each industry. Three efficiency variables are alternatively included in the model: a ratio of value added per employee, the ratio of costs of goods sold over net sales, and the capital-labor ratio. A series of regressions provide some insight into the nature of the structure-performance relationships.

Defense related firms are the most efficient of the three groups, probably because this group includes firms from high technology, capital intensive industry groups like industrial chemicals and computers. Efficiency played an important role in the prediction of profits for this group, while the evidence suggested a smaller role for market power. Efficiency appeared to play a smaller role in the primary defense firms than it did in the defense related group. The primary defense firms were the most concentrated and the evidence suggested a slightly more important role for the exercise of market power in this group. In manufacturing, market power appeared to play the dominant role in the determination of profits.

Acknowledgements

I wish to take this opportunity to thank the people who have assisted me in this research effort. First of all, I would like to thank my faculty advisor, Dr. Robert Allen, for his guidance and expertise. I also wish to thank Major Joe Coleman, Dr. Joe Cain, and Mr. Gary Louden for their support and assistance with the data processing stage of the research. I am also indebted to Major Robert Golden and Lieutenant Colonel Robinson of the Air Force Business Research Center for their assistance and cooperation in obtaining the data used in this thesis. Finally, I would like to thank my wife, Randi, for her loving support and concern during this time.

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Abstract

This study investigates and compares the factors that influence profitability in American manufacturing and in the defense industry. In particular, the relationships among market power, efficiency, and profits are explored for each group. In each case the unit of observation is the firm. Data is collected for a random sample of manufacturing firms, a set of primary defense firms from the top five defense oriented industries, and a set of defense related firms from the top eleven defense oriented industries. The basic model states that profits are a function of market power, efficiency, growth, product differentiation, geographic dispersion, research and development expense, and firm size. Market power is measured by the four-firm concentration ratio and the number of firms in each industry. Three efficiency variables are alternatively included in the model: a ratio of value added per employee, the ratio of costs of goods sold over net sales, and the capital-labor ratio. A series of regressions provide some insight into the nature of the structure-performance relationships.

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Three major data problems modify the impact of these conclusions. Firm based data was combined with industry based data measures to form this model. The firms were diversified to some extent, so part of the firm's profits were earned in markets that did not match the market-specific industry based measures, for example, the concentration ratios. This heterogeneity between data sources added noise to the model. The portion of the cost of goods sold over net sales efficiency variable that varied because of changes in factor prices, particularly labor costs, was undetermined. This reduced its effectiveness as an efficiency measure. Finally, the amount of capital supplied to defense firms was not included in the capital-labor ratio, making comparisons with this variable more difficult.

I. Introduction

Every economic market has a certain structure, a pattern of behavior, and a set of performance results. Market structure can be defined as those factors within the market environment that influence the course of business among the buyers and sellers operating within it. These factors include the number of buyers and sellers, the nature of the product or service, the amount of information available to market participants, and the degree of mobility of the buyers and sellers. The market behavior of firms consists of the various policies that participants adopt toward the market with regard to price, the characteristics of the product or service, research and development endeavors, collusive activities, and other actions that may influence the market. Market performance is a normative judgement about how well the market employs scarce resources to maximize output. Ideally, the market should raise the quality and variety of goods made available and improve the way factors of production are organized so that the good is produced more efficiently.

Basic economic theory states that a perfectly competitive market results in an optimal distribution of resources. Large numbers of selfish, but rational, buyers and sellers, acting through the "invisible hand" of the competitive market cause this optimal distribution of resources to occur where price equals the marginal cost of producing the good. Any deviation from the competitive assumptions results in some degree of monopoly. Market power refers to the degree of monopoly power arising from the various elements of market structure. Market power gives the firm (or cooperating group of firms) some degree of discretion in the control of the price and quantity of the product it sells. The main effects in the market are reduced output, higher prices, and excess profits.

A concept related to these issues is the concept of efficiency. Efficiency simply stated is the highest possible ratio between the value of outputs and the value of inputs. But there are a number of different types of efficiency. Shepherd (86:32-34) identifies three types of efficiency: allocative, X-efficiency, and dynamic efficiency.

Allocative efficiency refers to the optimal distribution of resources made possible by a competitive market place. A society allocates resources efficiently if no more of one good can be produced without having to cut back on production of something else. This occurs when output is at the level where marginal cost equals price for each product and firm. At equilibrium, price will equal the minimum possible level of average costs and each input's marginal value product will equal its input cost. Technology and preferences are brought into line with the relative scarcity reflected in prices. Market power shifts choices away from these efficient conditions. Prices rise above marginal costs, resulting in monopoly profits. Resources are diverted to markets where their marginal productivity is reduced. This misallocation of resources results in a social-welfare loss to society.

Internal efficiency, or X-efficiency, refers to the quality of management present in the firm. X-inefficiency is the excess of actual costs over minimum possible costs within the firm. This causes the firm to operate within the outer bound of its production possibilities surface. X-inefficiency is characterized by slack, waste, and mismanagement within the firm. Market power reduces competitive pressures so that cost minimization and profit maximization are no longer required for survival. This may cause organizational slack to emerge in the firm. Managers and workers, being human, tend to be less diligent and hard working when the need for it is lessened. At the extreme, the firm's costs may rise to absorb all the monopoly profits.

Dynamic efficiency refers to the optimal rate of technological change. It requires that present resources devoted to technological change be used just up to the margin at which their expected marginal payment equals their cost. Market power may reduce or improve this type of efficiency. The firm may try harder to invent new products to protect its market share, but it may be slow to apply these new products in an innovative way.

Technical economies of scale is another source of efficiency. The underlying technology may favor large scale operations. Long run average cost curves typically decline as output increases until some point is reached where costs level out over a broad range of output. Most industries contain some plants that are too small to exhaust all economies of scale. They are operating on the "high" part of the average cost curve, which causes a cost disadvantage and inefficiency.

Demsetz (29:1) has characterized efficiency as a differential cost advantage that results from scale economies, downward shifts in actual marginal cost curves, and/or superior products and marketing techniques produced by a skilled and innovative management. As a result, the firm can satisfy demand with a better product at a lower cost. This definition is another way of saying that efficiency is the highest possible ratio between outputs and inputs. On the societal level this notion of efficiency incorporates all the aspects of efficiency so far discussed. However, studies of market structure-performance relationships do not ordinarily include the idea of allocative efficiency because this concept is a social one, not restricted to any particular market of industry. As such, Demsetz's notion of efficiency within firms or industries includes scale economies, X-efficiencies, dynamic efficiencies, and any other factors that may lead to cost advantages or consumer preferences in the market. Caves (13:67-68) refers to these as technical efficiencies. This characterization of efficiency is now found throughout the literature on structure-performance relationships.

Empirical studies of structure-performance relationships consistently reveal a significant, positive relationship between industrial concentration and profits (95:193). The conventional view is that this occurs because leading firms in concentrated markets exercise their market power to extract monopoly profits for all through collusion. Demsetz (29:1) claims that efficiency is associated with increasing industrial concentration. Firms grow and capture a larger share of the market because they are more efficient and therefore are able to earn higher profits. These firms get to positions of power because they are more efficient, not by deliberately acquiring and exercising market power.

Demsetz tests his hypothesis by comparing profits for both large and small firms in concentrated industries. If supernormal profits are present in both large and small firms in concentrated industries, the firms should be equally efficient, isolating collusion as the source of the higher profits. But if supernormal profits are present only for the largest firms, as Demsetz found, then this superior efficiency must be causing both the increased concentration and the higher profits. This controversy is the central issue of this paper: How are efficiency, market power, and profitability interrelated, specifically in the American defense sector? To examine this question, I need to take a closer look at the structure-performance literature to see how previous models have been organized, what variables were used and how they were measured, and the types of data employed.

Chapter 2 contains a comprehensive review of these various models. The first part of the chapter deals explicitly with the different predictor variables used to explain the structure-performance relationship. The theoretical justification for each measure is reviewed, along with any competing viewpoints. Data and specification problems are outlined. The market classification schemes are then discussed, along with the relative merits of industry or firm based analysis. Finally, there is a discussion of the various viewpoints in the debate over the relative influence of market power and efficiency.

Chapter 3 discusses the makeup of the defense sector. The structure of the defense market, including both the buyer and seller sides of the market, is described in some detail. The conduct and performance of the market are also reviewed, with particular emphasis on the price and profit performance of defense firms. The latter part of this chapter is a review of the known studies of the structure-performance relationship in the defense sector and the results of those studies.

Chapter 4 describes the methodology involved in this study's empirical investigation of defense structure-performance r[illegible]onships and their comparison to non-defense relat[illegible]. The regression model is explained and justified [illegible] first part of the chapter. The Compustat data base is described, along with the inadequacies present in this firm based data. Finally, [illegible] construction and characteristics of the various defense and manufacturing data bases is explained.

The concluding chapter is an analysis of the results of this study and a comparison with previous work by other authors. Findings about the nature of market power, efficiency, and other factors is discussed, both for the defense sector and for all manufacturing.

II. Review of the Literature

The basic, mainstream theoretical model of industrial profitability identified by Martin (63:59) as common to most studies is:

$$\pi = f(C, BE, D)$$

where π is some measure of profitability, C a vector of variables describing the size distribution of firms as a measure of the ease of collusion, B a vector of variables describing the nature of entry barriers, and D a vector of variables describing the demand side of the market. Most explanations of market structure start with these major elements in some form, although the exact functional form is still a matter of debate. Market performance is generally measured by some measure of firm profits, the surplus of revenues over costs for a given period.

Profit Measures

A number of conceptual and data problems arise when measuring profits. Data is often imprecise or too aggregated, and accounting practices differ among firms and industries. Profit data is often biased toward under reporting for tax purposes, especially in highly profitable firms. On the other hand, relatively unprofitable firms may exaggerate profits to please stockholders or fend off merger attempts by other companies. Depreciation practices also differ widely. Jacquemin (45:142) points out that accounting profits may include some rent on owned property and/or some interest on invested capital, biasing returns upward. Weiss (95:196) observes that assets are often estimated up or down according to their profitability. For instance, investments that do badly are sometimes devalued on balance sheets to more accurately reflect their earnings potential. As a result, equity tends to increase in highly profitable firms and decrease in less profitable ones. Phillips (77:244-245) notes that such costs as advertising and research and development costs are normally expensed instead of capitalized, which biases profits upward in industries that invest heavily in these areas. Firms that value their assets at original cost also cause a bias when inflation is present, according to Weiss (95:196). The assets of slower growing firms will tend to be older so that their equity will be relatively undervalued and their rate of return on equity exaggerated relative to rapidly growing firms. Some profit elements are recorded as part of wages, especially in the more profitable firms (45:142). This can be most pronounced in small firms where the managers are often also the main owners. Salaries and prerogatives may rise above market levels to absorb some portion of excess profits. With these shortcomings in mind, four measures of profitability have been widely used in empirical studies of industrial organization. Martin (62:474-475) and Weiss (95:196-201) both identify these as rate of return on equity, rate of return on assets, price-cost margins, and rate of return on sales. Jacquemin (45:142-143), Phillips (77:244-245), and Shepherd (86:267-269) identify only the first three as popular measures of profitability.

A very popular profits measure (see Table 1 for a survey of studies on the structure-profits relationship) has been the rate of return on stockholders' equity, measured as $(\pi - T)/SE$, where π is before tax profit, T is tax payments, and SE is stockholders' equity. Hall and Weiss (42:320-321) hold this to be the most appropriate variable because it is the type of profit that managers would rationally seek to maximize. Comanor and Wilson (21:427) agree:

> ...because firms presumably maximize profits, rather than the sum of profits plus interest payments (referring to return on assets). The rate of return on stockholders' equity will therefore be a more sensitive indicator of the extent of freedom from competitive constraints.

In other words, these researchers feel that this form of profitability most accurately reflects the effects of market power. Most studies subtract out taxes in the numerator because firms focus on after tax profits, changing behavior if necessary to minimize T.

An alternative measure of profits is the rate of return on assets, usually measured as $(\pi + I - T)/A$, where I is the interest payments and A is total assets. This approach, like return on equity, is susceptible to variations in the type of depreciation employed. Jacquemin (45:143) notes that this approach also includes debt, which could be affected by the firm's capital structure. Stigler (88:124) argues for return on assets as a relevant profit measure:

> If lenders correctly estimate future risks on average, therefore, we should expect them to demand a nominally higher rate when they are asked to assume larger risks. If the rate is higher only by the actuarial value of future risks, we would say there is no risk aversion. In this case we would expect the net realized rate of return to be independent of the relevant amounts of borrowed funds and entrepreneurial equity in an industry...the essential symmetry in the theory of interindustry allocation of loan funds and equity funds supports the view that they should be combined in calculating the rate of return.

In this way the total return (profit plus interest payments) on all assets corrects for differences in leverage across industries (62:475). A number of empirical studies, including Demsetz, have used this approach.

The rate of return on sales (S) is usually measured by $(\pi - T)/S$. Weiss (95:198) argues that two firms with the same degree of market power would not have identical rates of return on equity if their capital requirements per dollar of sales differed. The firm with the higher capital requirements would have more equity and would receive more "normal profits" (profits needed to attract capital). This firm would therefore have a lower return on equity. Market power can be isolated more effectively, according to Weiss, by using return on sales and controlling for capital cost through the capital to sales ratio.

Collins and Preston (15:272) defend the use of a price-cost margin (PCM) as subject to fewer of the aforementioned arbitrary and distorting factors. This variable attempts to capture the effects of market power by measuring the relative gap between price and marginal cost. The price-cost margin is computed as (VA-W)/S, where VA is the value added, W is the payroll, and S is the value of shipments for the Census defined industry. Value added, according to Shepherd, (86:269) is the value of shipments minus materials, fuel, supplies, energy, and contract work. The numerator includes not just accounting profits, but depreciation, advertising costs, capital costs, central office costs such as research and development, taxes, rent, and untabulated input purchases. Weiss (95:227) claims that PCM's give the most accurate accounting profits, but the failure to control for advertising and central office costs detracts from their usefulness.

As noted by McFetridge (67:347) and others, the inclusion of capital costs in the PCM implies that, ceteris paribus, the PCM will be higher in more capital-intensive industries. These industries may also be highly concentrated. To account for capital costs and to avoid a possible spurious relation between PCM and concentration, an index of capital intensity (normally, the capital to sales ratio) should be included in the model as an independent variable, just as when return on sales is used as a profit measure.

Shepherd (86:269) points out that PCM's are usually based on average revenues and costs for entire industries. As such, they average together what may be highly differing data. A major advantage is that each element of the PCM equation is available from census data at the four digit level. This data is usually more reliable than the π, SE, and A measures necessary for other profit variables. This data is usually obtained from Internal Revenue sources (62:485). Thus PCM's are used extensively in industry based, cross sectional studies of the structure-profit relationship. The other three profit measures are much more common to firm based studies. Both Weiss (95:199) and Shepherd (86:269) point out the PCM is the most accurate measure of the relative gap between price and marginal cost, and most accurately reflects the role of market power and/or efficiency.

Size Distribution Measures

A major part of the variables that explain profitability is embodied in C, which is a measure of the size distribution of firms, otherwise known as a measure of concentration. A significant, positive relationship between concentration and profits is probably the most widely reported phenomenon in the industrial organization literature. Traditional oligopoly theory holds that this relationship reflects the ability of leading firms in concentrated markets to collude in some fashion (3:1). Encaoua and Jacquemin (32:89) have compiled a list of properties that a measure of concentration should possess to enjoy sound theoretical support. The first three concern properties related to size distributions when the number of firms is fixed: (1) The measure must not record a decrease in concentration if a smaller firm loses part of its market share to a larger firm; (2) For a given number of firms in the industry, the measure should take on its minimum value when the firms have equal shares; (3) If two industries composed of the same number of firms are such that the aggregate market share of the K biggest firms in the first industry is greater than the aggregated market share of the K biggest firms in the second industry, for K=1,....N, the same inequality should hold between measures of concentration in the two industries. The next two properties concern cases when N is variable: (4) If two firms merge, the measure must not decrease; (5), The measure should not depend on the absolute size of the market or industry, but rather on the relative market shares of the firms. In addition, according to Davies (26:306), the measure should provide a complete description of the two major dimensions of structure: the number of firms, and the size dispersion, or degree of variability in market shares. There is no general agreement as to the relative importance of these issues, but they can be used as a starting point to judge the merits and limitations of the existing concentration measures.

According to Weiss' (95:204-20) 1974 survey, by far the most common concentration measure used in empirical studies has been the four firm concentration ratio, which is the summed market shares of the largest four firms in the market. More recent research confirms that pattern

(49:445; 51:107-108). Concentration is the most common proxy for market power. In general, this concentration measure can be written

$$C_k = \sum_{i=1}^{k} S_i \quad (i=1,...K, K+1,...N)$$

where the ith firm has rank i in descending order of market share, C = the sum of shares of the top K firms, and S_i = firm i's share. Other values of K have been used in research, usually for the eight firm concentration ratio. Empirical studies have usually found similar results for concentration ratios with any value of K. Concentration ratios and other size distribution statistics are generally highly correlated (above .90), although Kwoka (49:445) questions the prevailing view that the choice of concentration measure is therefore unimportant. Kwoka argues that high correlations between measures of market structure and substantial correlation between one measure and industry performance need not necessarily imply a relationship between other measures and performance (49:447). Kwoka tested ten concentration ratios, C1 through C10, as part of a structure-performance study based on 314 four-digit 1972 SIC industries using PCM as the performance measure. He found the two firm concentration ratio empirically superior, which suggests industry's ability to coordinate behavior and raise price-cost margins may not be determined by C8 or C4, but by the leading two firms. Kwoka concludes the more aggregated ratios are too inclusive. Adding shares not causally related to performance may add enough random noise to reduce statistical significance (49:450). Since most studies based on C4 have already shown a positive, significant relationship between concentration and profits, Kwoka's results suggest that this correlation may be even stronger than previously believed. Before a researcher rejects the hypothesis that concentration and profits are related, he/she may want to test a less aggregated concentration ratio.

The value of a concentration ratio, C_K, varies between K/N and 1. This index clearly satisfies Encaoua and Jacquemin's five basic properties, but it is not without fault. The major flaw in concentration ratios is that they take no account of market share transfers outside the leading firm group of K firms (26:306; 50:183; 33:219). Changes outside the leading group may indicate important changes in the competitive situation, however. The concentration ratio also ignores size inequalities within the leading group of firms (itself arbitrarily defined) and emphasizes only the inequalities between the leading group and all other firms (26:306). As such, concentration ratios lose valuable structural information.

The number and size inequality of firms can be summarized by the Herfindahl index, which is simply the sum of the squared market share values:

$$H = \sum_{i=1}^{N} S_i^2$$

This measure accounts for all firms in the market, weighted according to relative market share. The smaller the firm, the less it counts (50:183). The value of a Herfindahl index varies from $\frac{1}{N}$, which occurs when all firms hold an equal share, to 1, given by the case of a monopoly where one firm occupies the whole market (37:51). It is easy to see theoretically that H is positively related to profits. Few researchers have been able to verify this empirically on a large scale because data on market shares is rare. McFetridge (67) has done so with Canadian data. Another way of expressing H is:

$$H = N\sigma^2 + \frac{1}{N}$$

where $\frac{1}{N}$ is the mean market share and σ^2 is the variance in shares. Kelly (47:51) shows that when firms are identical, $\sigma^2 = 0$ and $N = \frac{1}{H}$. In this case H is a numbers equivalent. That is, the reciprocal of H is the number of equal share firms which would generate that measure (47:51). In this case, $H = \frac{1}{N}$ and since there is no size dispersion, all concentration depends on fewness. Kelly rearranges terms to develop

$$H = \{(N-1)\sigma_*^2 + 1\}/N \quad \text{so that} \quad \lim_{n \to \infty} H = \sigma_*^2$$

where σ_*^2 is a standardized dispersion measure. In this case there is no concentration due to fewness, and all concentration depends on dispersion.

The Herfindahl index is clearly superior to concentration ratios because, in addition to satisfying the five basic properties mentioned earlier, it embodies both dimensions of firm numbers and share inequalities for the whole market. Many authors (50:183; 83:186; 47:50) feel H is the "ideal" measure of the size distribution of firms. Its major deficiency concerns the weights that are associated with the separate characteristics of numbers and share variance, which Kwoka (50:183) finds essentially arbitrary. He argues that use of the H index implies trade-offs between these structural features that may not be well considered. Phillips (77:242) agrees, arguing that share variance is weighted too heavily. The major practical reason for not using H as a concentration measure, according to Kelly (47:50) and Horowitz (44:464), is that it requires data on the market shares of every firm in the industry, which is not generally available. Since exact values for H are seldom available, Schmalensee (83:186) suggests using some sort of a surrogate summary index. He develops and tests twelve surrogates against known "ideal" H values for 114 four-digit manufacturing industries for 1947 and 101 such industries in 1954. Several of these complex surrogates constructed with more readily available information yielded values very close to the H values. The C8 and C4 concentration ratios did not approximate the known H values very well, although C4 did somewhat better.

A more recent summary concentration index is entropy, a measure of the degree of disorder of uncertainty in a market's structure (44:463). The entropy assigned to the distribution of market shares is given by:

$$E = \sum_{i=1}^{N} S_i \, LOG\left(\frac{1}{S_i}\right)$$

where S_i again represents market shares. The higher the entropy measure, the greater is the uncertainty for a firm to secure or retain any particular customer relationship (32:92). This weighting function tends to reduce the importance of the largest firms (32:92). The value of the entropy measure is minimized at zero when there is a monopoly and therefore no uncertainty in market shares. Entropy is maximized at LOG N when all market shares are equal for a given number of firms (44:463). In addition, any tendency toward the equalization of market shares increases E, and given comparable S_i distributions, increases in the number of firms also increases E. The latter factor plays a diminishing role because of the use of logarithms. The addition of another firm when numbers are already large becomes less significant (45:47). The degree of concentration,

$$C_E = \sum_{i=1}^{N} S_i \, LOG \; S_i$$

is an inverse measure of entropy and varies from -LOGN to 0 (32:92). The number $\frac{1}{10^{C_E}} = 10^{E}$ can be interpreted as the number of equal sized firms in an industry whose concentration is the same as given by C_E (32:92-93). Entropy (C_E) satisfies all the desired properties mentioned earlier. Horowitz (32) has shown empirically, using European data, that C_E is positively, significantly associated with profits. Entropy employs a different weighting scheme for the two dimensions of firm numbers and share inequalities. Also, if the sample being investigated can be disaggregated into different subsets (firms in different industries, countries, size groups), one can determine the contribution of each subset to total entropy by breaking down the over-all index into its different weighted elements (45:47). Another related measure is relative entropy, which is entropy divided by its maximum value:

$$E_R = \frac{E}{\mathrm{LOG} N}$$

This measure shows how the actual degree of dispersion compares to the maximum amount possible for a given number of firms. Miller (69:110-111) has shown empirically that relative entropy is positively and significantly associated with price-cost margins. A dispersion of output shares close to the maximum allowed by E and N permits a greater possibility of effective collusion and thus produces a greater price-cost margin, according to Miller (69:110). Entropy measures are seldom used in empirical studies (see Weiss survey, 95:204-220) for the same reason that H is rarely used: market share data is generally unavailable.

A number of lessor known concentration measures exist in the literature. The Gini coefficient measures the area between a Lorenz curve, x, representing an accumulating total of market shares in the industry, and a diagonal line, f(x), representing an accumulating total of firms with equal market shares (45:49). The Gini coefficient can be written as:

$$G = \int_{0}^{N} \{x-f(s)\}dx$$

The number of firms does not influence G because a market composed of two firms with 50 percent of the market each would result in the same concentration value as a market of twenty firms with 05 percent of the market each. G measures share inequalities fairly well, but the total disregard for one dimension of structure, firm numbers, seriously weakens its effectiveness as a measure of collusion (26:306). The Rosenbluth index is based on the rank of each firm as well as its market share. It gives more weight to the numbers and importance of smaller firms (86:188-189). The Linda index, popular in European research, attempts to define the boundary between the leading, strategic group of oligopolists and the other firms (45:48).

Kwoka (50:184) separates the two main aspects of a concentration measure (firm numbers and size inequality) into two separate independent variables. Firm numbers are measured directly and size inequality is measured by a "dominance" index (D), given by

$$D = \sum_{i=1}^{N-1} (S_i - S_{i+1})^2$$

where the S_i's are ordered from largest to smallest. This measure focuses on the pattern of shares in an industry, rather than the simple sum (as with concentration ratios) or some measure of dispersion combined with firm numbers (as with E or H). When large gaps occur between consecutive shares, inequality or dominance is present and D tends to unity. With equal size firms the index falls to zero, regardless of the number of firms (50:184). In industries with a long thin tail of small firms, D changes very little over the range of the distribution. Kwoka tested this two part concentration measure empirically, and found higher price-cost margins in industries dominated by one or two leading firms, rather than in industries with equal size firms or with large concentration ratios regardless of how market shares were distributed (50:188).

The relationship between concentration and profits may be disjointed. Geithman, et al (38:346) have claimed that some critical concentration ratio may exist below which there is no relationship between concentration and profits. Leading firms can collude effectively to raise their profits only when this critical ratio has been exceeded. At the critical ratio firms become few enough to recognize and exploit their interdependence. Kwoka (51) related 1972 price-cost margins to leading firms' market shares for

314 four digit industries. He found that margins increased with large market shares for the two leading firms, decreased with large third firm shares, and were not significantly affected by shares for smaller firms (51:108). The share effects also appeared discontinuous, with definite breaks. The strongest concentration effects appeared with a two firm concentration ratio around .35. There was no significant further effects on margins above or below that level. Geithman, et al (38:347) criticized this approach because it is based on a broad range of industries. They claim that many other variables beside concentration affect the ability to collude. They write that it is probably easier to collude when customers are many and small, when sales are to buyers who report all bids honestly (the government), and when buyer turnover is low, among other reasons. Since these are industry-specific characteristics, they conclude that critical concentration ratios differ greatly among industries, a result they verified empirically.

Several studies focus on the role of market share as an important structural determinant of profitability (15, 34, 35, 87). These types of studies have generally been difficult because accurate business unit level data has not been available. Shepherd uses market share (M) and a group variable G together to predict performance, where G(C4-M) is meant to capture the role of the group as distinct from the firm's share. Shepherd studied this question with both firm (87) and industry (85) based data. Market share data was derived from the Fortune Plant and Product Directory and a large variety of other sources. He found that profitability (return on equity after tax for firm study, PCM for industry study) was positively associated most highly with market share, while concentration and the group variable showed relatively little association independent of the role of market share. Shepherd (86:178) sees the strong role of market share shaped by the underlying determinants of market power and scale economies. Gale (34) also examines the role of market share in a firm based study using return on equity after tax as a profit measure. Gale uses Standard and Poor's "Compustat" data, the Bureau of Census' "Industry Profiles" and Dun and Bradstreet's "Dun's Market Identifiers" to construct market share data. Gale hypothesized that share should interact with concentration in determining profitability, with profit more responsive to share in highly concentrated markets (34:413). He found that high market share was associated with high rates of return and that this effect was enhanced by high concentrations. Gale stresses the interactive effects of share and concentration in determining profitability. Caves, Gale, and Porter (15) later re-examined this relationship using business unit level data collected by the Profit Impact of Market Strategy (PIMS) program of the Strategic Planning Institute. They conclude that a behavioral relationship existed between share and profitability for firms in concentrated markets.

A recent study (35) by Gale and Branch attempts to test the relative explanatory power of concentration and market share in the profitability equation. According to Gale and Branch, proponents of the view that concentration plays the prominent role assume that most firms operate near the flat portion of their long run average total cost curve and that the burden of maintaining prices through excess capacity absorption falls primarily to the high share firms. Those who see market share in the prominent role claim that cost advantages resulting from scale economies reflect a positive relationship between share and profits. So, according to Gale and Branch (35:85), those who think concentration facilitates oligopolistic collusion and higher profits expect the concentration-profits relation to dominate, while those who feel that market share facilitates efficiency see the market share-profits relation as dominant. Of course, if both scale economies and collusion affect profits, both market share and concentration may play a significant role in profits. Gale and Branch also use the PIMS data from the Strategic Planning Institute for business unit level data in their firm based study. Their profit variable was return on investment, a choice they defend by citing high correlations with return on sales and return on equity. They find that market share contains far more explanatory power than either concentration or even a share/concentration interactive variable (35:90). They conclude that the dominant relationship is not between concentration and industry profits, but between market share and firm profits. Thus, according to this study, lower costs achieved through efficiencies associated with scale economies account for most of the higher profitability of large share firms, rather than the higher prices made possible by oligopolistic cooperation achieved through concentration (35:98). Gale and Branch further claim that the weak positive relation commonly observed between concentration and profits with industry or company wide data represents a blurred, aggregate view of the more basic underlying link between share and profits via efficiency.

Kwoka (51:108) argues that past failures to obtain a more powerful concentration-profits relationship were caused by concentration ratios (commonly C4) that were too broad because the two firm concentration ratio is a more accurate index of market structure and oligopolistic coordination. Gale and Branch (35:99-100) address this hypothesis by dividing their data base into two groups: one group with firms ranked first or second in their industries, and a second group with all other firms. They find the share index highly significant and concentration insignificant in both regressions. These results verify the share-profitability via efficiency relationship over Kwoka's profits-two firm concentration via collusion relationship.

Entry Barriers

A second major set of variables used to determine profitability is entry barriers (B). Entry barriers are factors that limit the "likelihood, scope, or speed" (86:182) of potential firms to enter the market. Shepherd (86) and Jacquemin (45) both identify three major sources of barriers: economies of scale, absolute cost advantages of established firms, and product differentiation. Other lesser variables are also discussed in the literature. These include research and development expenditures, risk, diversification, and growth. Entry barrier variables are usually difficult to measure reliably. In addition, each source of entry barriers is important only in some industries, or perhaps only to certain firms within industries. There is some question about whether or not entry barriers exert a significant influence on profitability independent of concentration. Mann (58, 59) and Orr (74) have concluded from their studies that high barrier industries are significantly more profitable than other industries, independent of concentration. On the other hand, Martin (46) and Rhoades (80) have concluded that barriers to entry influence profitability only through their influence on concentration no matter what type of profit measure is used. The former view appears to be more prevalent in the literature.

The weight of empirical evidence indicates that long run average total curves are flat over broad ranges of output. For this reason the point at which they are first minimized becomes important when considering entry barriers. If the minimum optimal output represents a significant share of market demand and if the cost curve rises sharply to the left for outputs smaller than minimum efficient plant size (MES), the potential entrant faces a barrier to entry (45:119). MES is commonly used as a measure of scale economies in empirical studies (Ref 17, 27, 56, 67). Lyons (56:19) identifies four major barrier effects of MES: (1) A large MES relative to market size results in difficulties attracting enough customers away from existing suppliers to achieve full production economies, (2) A large MES raises initial capital requirements, (3) A large MES causes difficulties attracting labor from established firms, and (4) A large MES results in an entrant reducing the product price and/or provoking retaliation by established firms.

Since MES cannot be measured directly, several proxies have been suggested. Weiss (95) suggests using the midpoint plant size as a proxy for MES. The plant size at the midpoint of the output distribution is taken to represent MES. Comanor and Wilson (21) suggest the average size of the largest plants accounting for 50 percent of industry shipments. They found this measure highly correlated with the Weiss proxy (17:135). These two measures have become the most common MES proxies (17, 47, 48, 90) in the literature and are usually expressed as a percentage of industry sales by dividing by total sales or shipments (MES/S but hereafter still referred to as MES). Caves, Khalilzadeh-Shirazi, and Porter (17) add a cost disadvantage ratio (CDR) to the Weiss MES measure. They argue that entry conditions will vary with both the minimum scale necessary for cost minimizing production and by the cost penalty associated with less than minimum efficient scale operation. The CDR indicates the disadvantages associated with sub-optimal scale. They define the CDR as the average value added per worker in plants supplying the lower 50 percent of industry value added divided by the average value added per worker in plants supplying the top 50 percent (17:135). A large CDR indicates that smaller plants are on a more nearly equal footing as the larger plants. Caves, et al constrained the CDR to less than unity. They found empirically that CDR and MES interact to determine scale economy entry barriers and that large MES's generate significant entry barriers only when the CDR of small scale plants is "significant". Lyons (56:131) and Davies (27:290) have both noted that these MES proxies and plant concentration are highly correlated. Davies notes that these MES proxies are inversely related to firm numbers and positively related with size inequalities, two properties of any good concentration measure (27:290). Davies recommends that these proxies not be used for this reason, and suggest Lyons' proxy (56:26-27), which is based on observing the relative incidence of multi- and single-plant firms in the industry.

A second type of entry barrier is caused by absolutely lower levels of production costs in some firms across the entire range of output. This variable is generally called absolute cost advantage. Shepherd (86:182) describes a "size barrier to entry" based on the ability to gather large amounts of relatively cheap capital. This type of barrier especially inhibits entry into capital intensive industries where MES is large. Other cost advantages include patents, exclusive ownership of supply sources, and favorable locations (86:182). Caves, Khalilzadeh-Shirazi, and Porter (17:137) measure absolute cost advantages with an absolute captial requirements variable, calculated as the product of MES and the industry capital-sales ratio. The higher the ACR, the higher the entry barrier will be. Martin (62), Orr (74, 75), and Porter (78), among others, have since used ACR as an independent variable in their empirical studies of the structure-performance relationship. Martin (62:476) points out that MES and ACR are functionally but not linearly related; he finds their correlations to be less than .5 in his study.

A third major source of entry barriers is provided by strong consumer preferences for established, differentiated products. Product differentiation transforms similar goods into imperfect substitutes so their prices can differ and the market can be segmented. Product differentiation arises primarily from advertising and other market strategies.

An established firm can create preference for brand names, which requires the potential entrant to advertise heavily to overcome the advantage. The most common proxy for product differentiation is the advertising-sales ratio (A/S) popularized by Comanor and Wilson (21:428). This variable is measured by dividing industry advertising expenditures by industry sales. A number of empirical studies have used this measure (43, 62, 75, 78). The basic data difficulty with A/S, according to Phillips (77:245), is the absence of comprehensive, consistent information across industries. Cowling (24:10) also finds conceptual problems with A/S. Cowling suggests that A, the absolute advertising in the industry, is a more accurate measure of this entry barrier because the relevant measure is the absolute volume of advertising messages received by the consumer. A large industry like automobiles may have a very low advertising-sales ratio (.6 percent according to Comanor and Wilson) but have a much higher advertising impact due to larger absolute expenditures compared to the perfume industry with an advertising-sales ratio of 15.3 percent (again, according to Comanor and Wilson) (24:10). Shepherd (85, 87) has favored the use of A over A/S for this reason. Another approach to advertising has been the use of a dummy variable to account for systematic differences in advertising expenditures (6:291). Consumer goods industries advertise far more heavily than producer good industries, so this dummy variable assigns a value of one to consumer goods industries and a value of zero to producer goods industries (80:154). This has been a popular approach in recent empirical studies (3, 6, 17, 48, 51, 80).

Research and development intensity is occasionally described as an entry barrier. Mueller and Tilton (71:578) justify this belief by citing two main factors. First, barriers exist to the extent that scale economies exist in the R&D process. Secondly, R&D barriers exist when patents and technical knowledge accumulate for the established firm. Orr (15:61) measures R&D intensity by dividing R&D related expenditures by industry sales. Orr finds R&D intensity moderately important as an entry barrier. Martin (64:30-31) likewise expects the impact of R&D activity on profitability to be positive, assuming that R&D expenditures reduce costs or create a product differentiation advantage. However, he cites a recent study by Caves, Porter, and Spence that found a negative impact. They suggest the reason for this is that heavy investment in R&D may signal a market environment in which actual and potential competition is intense.

Risk is also occasionally mentioned as a possible entry barrier. Orr (75:61-62) believes that business people are by nature risk averters so that, for any given profit rate, as the standard deviation of industry profits increases, incentive to enter decreases. His measure of risk is therefore the standard deviation of industry profits for some arbitrarily defined recent period. Stonebraker (89:33) sees risk as the vehicle through which all other entry barriers operate. For instance, the risk of entering an industry with significant scale economies is likely to be high, so any excess profits of established firms will more likely be protected from new competition.

Industry growth is sometimes described as a barrier to entry. Industry growth is usually defined as a percentage change in sales of the current year over some recent year. If the industry grows rapidly, the dominant firm(s) may find it more difficult to exclude new entrants. Martin (63:60) states that growth should make entry easier, all other things being equal. Orr (75:60) agrees, and finds a weak, positive relationship between growth and profitability. But Shepherd (87:26) argues that growth's effects may be ambiguous. Diseconomies may occur at high growth rates because a series of reorganizations may become necessary to cope with the greater size. These reorganizations may detract from orderly management and quality controls could deteriorate. Also, growth may be achieved through pricing strategies that sacrifice current profits for a larger market share in the future. These factors may or may not outweigh the positive entry barrier effects of growth. Bradburd and Caves (11:635) have drawn a distinction between expected or long term growth and unexpected growth in their study of the profits-growth relationship. They identify three current, independent theoretical models of growth. First, unexpected demand growth will increase profits when this demand exceeds the industry's planned production or capacity. The duration of these windfall profits will vary with the time required to change production or capacity. Secondly, unexpected growth may affect profits by increasing the recognition of mutual dependence in oligopolistic markets. Profits will also increase with expected or long term growth rates in concentrated industries through structural conditions correlated with seller concentration. One model indicates a negative profits-growth relationship. If the amount a buyer purchases now increases the amount demanded in the future through habit, reduction of uncertainty, or technical interdependencies, then a lower current price can be expected to increase growth. Bradburd and Caves (11:644) tested these theories by separating expected and unexpected growth in their empirical study. They found both forms of growth positively related to profits, which supports the first two theoretical models mentioned. The third model was not supported by their data, probably because industry's pricing strategy emphasized current profits over future profits.

The third major set of variables used to determine profitability is contained in D, the variables that explain the demand side of the market. The structure of the demand side of the market will have an important influence on profitability because the number of buyers may be small enough to have a significant influence on the market price. Buyer concentration or countervailing power is the demand side economic power that may constrain the exercise of market power by firms on the supply side. Another major aspect of D is the market price elasticity of demand, E. Higher elasticities will tend to result in lower prices for the industry as firms will be more likely to lower prices to benefit from the expanded amount sold. Some authors (63:77) include growth as one of the variables describing the demand side of the market. In fact, growth can be seen as both an entry barrier and a demand variable. There is overlap in the three categories of variables. All variables tend to act together to affect profitability, which blurs some of the distinctions in categories.

Lustgarten (54:125) investigates the impact of buyer concentration by formulating measures of buyer structure and correlating them with the traditional measures of seller structure, conduct, and performance. In this way, he tests Galbraith's theory of countervailing power, which argues that high seller concentration induces buyers to grow larger and more concentrated to counter the sellers' power. Prior to Lustgarten, the empirical industrial organization literature had largely ignored buyer structure (41:488), making it difficult to test bilateral oligopoly or bilateral monopoly models. In general, fewness of buyers causes the quantity taken by each buyer to significantly influence market price. The interdependence associated with an oligopsony might be expected to produce some buyer collusion. Lustgarten (54:126) notes, however, that collusive agreements are less likely to be successful for buyers than for sellers, because firms are typically sellers in only one market but buyers in many markets.

Lustgarten (54:127) computes four measures of buyer concentration. His buyer concentration ratio (BCR) is the average four firm concentration ratio of consuming industries weighted by the volume of sales to that industry.

$$BCR_i = \sum_{j=1}^{n} \frac{X_{ij}}{S_i}(SCR4_j)$$

where n = number of consuming industries, X_{ij} = sales of producing industry i to consuming industry j, S_i = total sales of producing industry i, and $SCR4_j$ = four firm seller concentration ratio of consuming industry j. Relative buyer firm size (RBFS) is the weighted average firm size of consuming industries divided by the average firm size of the producing industry.

$$RBFS_i = \sum_{j=1}^{n} \frac{X_{ij}}{S_i}\left(\frac{VA_j}{n_j}\right) / \frac{VA_i}{n_i}$$

where VA_j = value added for consuming industry j, n_j = number of consuming industries j, VA_i = value added for producing industry i, and n_i = number of producing industries i. Order size is measured by the logarithm of annual firm purchases (AAFP) of consuming industries.

$$AAFP_i = \log \sum_{j=1}^{n} \frac{X_{ij}}{S_i}\left(\frac{X_{ij}}{n_j}\right)$$

Buyer dispersion (DSPH) measures the number of industries in which consuming firms operate as well as the inequality of sales in each sector. DSPH is a Herfindahl index in which lower values indicate greater dispersion.

$$DSPH = \sum_{k=1}^{n} S_{ik}^2$$

where S_{ik} is the share of industry output i consumed by industry k. Lustgarten considered the federal government as one consumer. He found that all four measures of buyer structure produced a negative effect on price-cost margins (54:128), and BCR was more robust than the other three measures. He also found that the impact of buyer concentration on seller price-cost margins was likely to be the greatest when seller concentration was high, which verifies Galbraith's theory of countervailing power.

Guth, Schwartz, and Whitcomb (41:489) argue that Lustgarten's BCR is not a true four firm BCR, but an estimate of a 4N-firm BCR because it measures the proportionate purchases of the four largest buyers in N industries. These 4N firms are not necessarily the 4N largest purchasers since the number five firm in one industry may purchase more than the fourth largest firm in another. Thus Lustgarten's BCR seriously overstates the true BCR(4N). Guth, et al offer another estimate made by ranking consuming industries by the value of concentrated purchases, $X_{ij}SCR4_j$, and selecting the top M. Then the 4M firm BCR is

$$BCR(4M)_i = \sum_{j=1}^{n} \frac{X_{ij}}{S_i} SCR4_j$$

Conventionally, M would take on values of 1, 2, and 5, producing 4, 8, or 20-firm BCR's which could be used in conjunction with existing SCR data. However, Lustgarten (55:492) in turn argues that this BCR(4M) variable understates the true BCR because the largest firm in an excluded industry might consume more of i than any of the top four firms in an included industry. He identifies a second downward bias when one or more of the 4M purchases operates in more than one consuming industry, causing the included X_{ij} to represent only part of the amount purchased by the largest buyers.

The second major demand variable is the market price elasticity of demand. Johnson and Helmberger (46:1219-1220) have shown that the impacts of changes in output and market share decrease at an increasing rate with increases in the price elasticity of demand. They use the formula for price elasticity of demand

$$-E = \frac{dQ}{dP} \cdot \frac{P}{Q}$$

to develop the following relationship:

$$\frac{\partial K}{\partial E} = \frac{cS_i}{E^2}$$

where $\frac{\partial P}{P} = K$, S_i = the market share of the ith firm, and c is some number so that cX_i gives the change in the ith firm's output where X_i is the original output of the ith firm. If we let c = .1, a firm with a 20 percent share of the market when E = -.3 has about the same effect on market price as a firm with a 60 percent share of the market when E = -1.2 (46:1220). Perhaps this is why Cowling (24:10) has described the omission of price elasticity of demand from inter-industry studies of profitability as "probably the most serious and basic deficiency in existing work." Cowling and Waterson (25:267) point out that measures of price elasticity of demand are not generally available at the appropriate level of disaggregation and therefore are not included in empirical studies of the structure-performance relationship. The omission of this variable implies the assumption that demand elasticity is constant across industries, but this constant elasticity assumption has been widely refuted (24:1; 25:267; 46:1220; 64:38). These authors all feel the omission of this demand side measure significantly detracts from the value of the model. Cowling (24:2) notes that some researchers have restricted their sample to consumer goods industries in response to this concern, but Cowling considers this an ineffective remedy. Cowling and Waterson (25:269) shift their focus away from explaining static inter-industry differences to explaining intra-industry changes over time, assuming the constancy of industry price elasticities over time as a less heroic assumption than static constancy across industries. This side-steps the issue by confining study to a single industry. Cowling (24:10-11) suspects that price elasticities of demand may vary so widely among industries that it reduces significant relationships and explanatory power. This problem may even account for the occasional negative sign in the concentration-profits relationship in multivariate studies.

One other remedy was recently suggested. Pagoulatos and Sorensen (76:740) obtain a price elasticity of demand variable from regression estimates of demand equations for each industry in their study. A consumer demand equation was estimated for each industry using annual data for the 1952-75 period. Their general demand equation was estimated as:

$$Q_i = b_0 + b_1 P^i + b_2 Y$$

where Q_i is an index of per capita consumption of goods in industry i (1967=100), P^i an index of prices for goods in industry i deflated by the consumer price index (1967=100), and Y an index of disposable per capita personal income deflated by the GNP deflator (1967=100). The estimated value of the price elasticity of demand was calculated as:

$$E^i = b_1 (\overline{P}^i/\overline{Q}^i)$$

where $\overline{P}^i$ and $\overline{Q}^i$ were the mean values of the two variables and b_1 was the coefficient from the estimated demand equations. Pagoulatos and Sorensen (76:740) found their price elasticity of demand variable significantly affected price-cost margins.

Control Variables

Some background or control variables have also been suggested in the literature. As mentioned in the discussion of performance measures, a capital-output measure is required as a control variable when price-cost margins or return on sales is used as a profitability measure so that inter-industry differences in capital intensity can be properly accounted for. Collins and Preston (20:285) have suggested a measure of geographical dispersion to account for differences in national Census data and the geographical extent of the true markets. Some markets may not be national, but limited to local or regional areas. The index of geographical dispersion for each industry is the sum of the absolute values of the differences between the percentage of value added accounted for by firms in each region and the percentage of total manufacturing value added accounted for by that region.

Strategic Groups

Several authors have discussed the concept of strategic groups within industries. Newman (72:417) defines a strategic group as those firms within an industry that pursue highly symmetrical corporate strategies. Newman identifies two reasons (72:417) why firms competing in the same market may not all choose the same strategies even though they presumably share the common goal of long run profit maximization: (1) They may possess differing, long term firm-specific assets that create differing rates of return for any given incremental commitment of resources, and (2) the products they produce may differ significantly in nonprice attributes according to varied buyer preferences. The firm's strategic choices include vertical integration, product differentiation, diversification, production technology, distributional arrangements, and so on. Porter (78:214) argues that these strategic factors play an important role in the different profit rates seen among firms in the same industry, citing the performance of General Motors and IBM within their respective industries.

Porter (78:215) goes on to argue that strategic groups of similar firms affect the expected distribution of firm's profits in two ways. First, entry barriers will differ among strategic groups. Entry into a strategic group that produces a full line of nationally advertised brands will be more difficult than entry into a strategic group of regional producers making the same product. Second, the presence of multiple strategic groups affects competitive rivalry. Mutual dependence is more readily recognized within a strategic group, so the configuration of groups will help determine the pattern of cooperation in the oligopoly. Porter (78:218) claims that the more numerous and more equal in size the strategic groups, the more strategic asymmetry enhances production the more cooperation across the industry. The more corporate strategies differ among strategic groups, the more difficult industry wide collusion becomes. Also, the more strategic groups must compete for the same market segment customers, the more rivalry increases and the possibility for coordination increases. Caves and Porter (16:249-257) develop the concept of mobility barriers as a more general interpretation of entry barriers, where mobility barriers offer not only protection from potential entrants into the industry, but also include those barriers that are specific to certain strategic groups. These group specific barriers protect member firms from entry by members of another group. Porter (78:219) concludes that the firm will have higher profits if it is located in a strategic group with the best combination of mobility barriers, insulation from inter-group rivalry, and fewest other members within the group.

Newman (72:422) identifies strategic groups by searching for a "clear break" in the market share distribution to isolate the "leading firms" strategic group first. With leading firms identified, the industry's strategic groups were defined by those firms' basic businesses and the relationships between those businesses and the industry. Newman chooses a Herfindahl index constructed over the shares of strategic groups in the leading firms' total share of industry sales as a summary measure of industry group complexity.

Thus,

$$H_j = \sum^{i} (s_{ij})^2$$

where S_j = the share of industry j's sales held by the industry's leading firms and s_{ij} = strategic group i's share of S_j. Newman found that increasing heterogeneity of strategic groups worsens the fit of the conventional structure-performance model, although it does not alter the values of the underlying relationships (72:423). He concludes that heterogeneity of strategic groups frustrates cooperation and increases the difficulties of enforcing a consensus.

Porter (78:220) uses the relative size of a firm in its industry as a proxy for strategic group membership, dividing firms in each industry into two categories of leaders and followers. Industry leaders were the largest firms in the industry, accounting for about 30 percent (an arbitrary figure) of industry sales. All other firms (after excluding fringe firms) were designated as followers. Porter found low correlations between rates of return for leading firms and follower firms in the same industry. This finding refutes the shared asset theory, which holds that market power is an asset shared by all firms in an industry in proportion to their sales, so that profit rates within the industry should be equal except for random disturbances (78:223). Porter's low correlations indicate that profitability depends on the firm's position within the industry and the array of strategic groups present. He found that the regression equations explaining firm profitability differed significantly in the leader and follower groups, verifying that important differences exist in the structural features that explain profits for firms situated differently in the industry. In fact, Porter found that concentration had a significant, negative impact on follower group profits, a result consistent on the surface with Demsetz's findings (78:224). Porter argues that the theory of strategic groups could explain more about firm profits if there were some good way to capture their influence beyond his crude leader/follower dichotomy, but little work has been done in this area.

Simultaneous Equations

Most empirical studies of industrial organization have been in the context of single equation models. Pagoulatos and Sorensen (76:728) criticize this approach because it fails to account for the simultaneous nature of the interactions among elements of structure, conduct, and performance. Single equation models are based on the notion of a unidirectional causality running from structure to conduct to performance, but a number of authors (39, 61, 76, 90) have suggested that at the same time market conduct and performance are likely to feedback and influence structure. For example, traditional theory holds that advertising leads to higher profits. But, as Pagoulatos and Sorensen (76:729) point out, the direction of causality may run both ways; high profits may also lead to more advertising. Martin (61), Pagoulatos and Sorensen (53), and Strickland and Weiss (90) have all studied the structure-performance relationship with simultaneous equations so that the dynamic nature of the relevant interrelationships could be captured more effectively.

These authors have all used models involving three simultaneous equations that represent relationship between concentration, profits, and advertising. The profit equation is constructed in the usual manner:

$$PCM = f(C,BE,D)$$

where the BE vector includes AD/S, the advertising-sales ratio. There is less agreement on the proper form of the concentration measure. Martin (61:642) formulates the concentration equation as

$$C = f(BE,GR,PCM^*,C^*)$$

where BE is a vector of entry barriers, GR is past industry growth, PCM* is past profitability, and C* is past concentration. Pagoulatos and Sorensen (76:733) do not include the last two "independent" variables, and Strickland and Weiss (90:1111) exclude the last three. The advertising equation is defined as

$$AD/S = f(PCM,C,D)$$

in some form by all three authors. Linear forms are assumed and specified for estimation. Strickland-Weiss and Martin use two-stage least squares regressions to test their simultaneous equations instead of ordinary least squares (the usual procedure), which would bias the model because of its simultaneous character (90:1116). Pagoulatos and Sorensen (76:736) use three-stage least squares regression to avoid contemporaneous correlation of errors across equations. Pagoulatos and Sorensen (76:740) found that advertising significantly influenced both concentration and profits, suggesting that advertising intensity acts as an entry barrier. On the other hand, concentration and profits both significantly influenced advertising intensity, completing the feedback relationship. Strickland and Weiss (90:1119) found that the advertising intensity increased concentration, which they suggest means that economies of scale are substantial. On the other hand, they found advertising's effect on price-cost margins only mildly higher than what might be expected considering that advertising expense is included in those margins. This suggests that the product differentiation entry barrier is not very high (90:1120). Martin's major conclusion is that entry barriers affect profitability only through their effect on concentration (61:644). Opinion on the need for a simultaneous equation approach is not unanimous, however.

Cowling (24:1) has argued that although the structure-performance relation is only one equation embedded within a set of equations in which structure, performance, and behavior are determined, the feedbacks in the system should have substantial lags that allow us to treat a single equation separately. He verifies this by comparing results for the same set of data using both the simultaneous equation approach and the traditional single equation model.

Problems With Aggregation

Most researchers have found a significant, positive relationship between concentration and profitability (see Table 1 for a survey), but others (12,29), using similar data, failed to find this association. According to Gale and Branch (35:86), these different results may stem from how authors deal with the imperfections inherent in the data tested. For example, how are national concentration data adjusted for industries that compete at the regional level? What price index should be used? What are the proper determinents of profitability? Different approaches tend to yield different conclusions, according to Gale and Branch. In addition, the concentration-profits relation relates to the product-line level, but most available data is at the firm or industry level. An analysis restricted to aggregated industry data may produce a spurious positve relation between concentration and profits, according to Branch and Gale (35:98). Phillips (77:246-247) argues that the common use of weighted averages (averaging values across the industry) for all the variables on each side of the regression equation can also result in biased results if there is a correlation between size and any of the weighted dependent or independent variables.

Most authors have used Census or IRS data for their empirical studies (95:201-220). The Census has a detailed system of "standard industrial classifications" (SIC) that groups sectors by numbers ranging from 01 to 99 (86:199). The two-digit classification level is a broad description of a sector of the economy. For instance, SIC code 37 is "transportation equipment" (86:216). The two-digit level corresponds roughly with a "major" industry, as defined in IRS data. The three-digit SIC level is less aggregated, and roughly corresponds to an IRS "minor" industry (95:205). The four-digit SIC level is still less aggregated. SIC code 3711 is "motor vehicles and passenger car bodies" (86:218). Most research has focused on the four-digit level or the IRS "minor" industry level (95:201-220). Shepherd (86:199) contends that this level of aggregation is too broad. This type of data can spill over correct market boundaries because it sometimes lumps distinct products and geographical markets together. Shepherd argues for the five-digit level as a more accurate measure of the true scope of average markets. If this cannot be done, the data must be adjusted ad hoc for distinct products and/or corrections made for the true geographical extent of the markets.

Other researchers have recently used business unit level data in their studies. This data treats the different product line divisions of diversified firms as separate business units, since profits and other factors can vary significantly among segments of a single firm. Before this type of data became available, data limitations had restricted cross-sectional structure-performance analyses to either industry level variables or firm level variables which aggregate across disparate business activities within the corporation. Caves, Gale, and Porter-1977 (15) and Gale and Branch-1982 (35) have used business unit level data from the Strategic Planning Institute's PIMS program, while Martin-1982 (64) and Ravenscraft-1983 (79) have used this type of data from the Federal Trade Commission's (FTC) Line of Business survey. In the case of the FTC data, the line of business units ranged from 1 to 47 over the 275 surveyed industrial categories. Of course, the major advantage of line of business data is that it represents the level that the important structure-performance relationships occur (35:98).

The two basic model types are firm based (including business unit level studies) and industry based analyses. The major differences are delineated by Shepherd (85:532). Firm based studies generally use return on equity or return on assets as a performance measure, while industry based studies invariably use price-cost margins. Biases in PCM caused by inter-industry variations in capital intensity are mitigated by using a capital intensity variable in the industry studies. Market share is sometimes used in firm based studies as a measure of the size distribution of firms. Information for most entry barrier variables is usually not available for industry based studies. Shepherd (86:265) points out that if complete and perfect data were available, the models would be much more complex. Since data is not complete or perfect, tradeoffs must be made between the importance of the factor in question and the quality of data available about it. Some variables, like demand elasticities, should be included on a theoretical basis, but data problems have kept authors from doing so.

Market Power Versus Efficiency

The existence of substantial industrial concentration in the United States, especially within manufacturing, is well documented (5:129). It is also well known that concentrated economic power entails social costs because market power leads profit-seeking firms to misallocate resources. Estimates of the welfare loss to monopoly power range from as little as .06 percent of GNP (Arnold Harberger) to as much as 6 percent (5:130). Those who defend existing concentration, most notably Demsetz (29) and Carter (12), argue that concentration itself is explained by the superior efficiency of the large firms. According to this view, the virtues of large size outweighs the social cost (firm size and concentration are not directly related but, for any given market size, large firms will imply higher concentration by an index). Hence, deconcentration might lower industrial prices slightly, but this gain would most likely be more than offset by higher costs, yielding a net loss to society (12:436). Opponents of deconcentration cite a number of arguments. McGee (68) contends that technical efficiencies, including but not limited to scale economies, justify concentration. Some firms are more efficient because they are better at providing products that consumers value more highly relative to what they cost to produce. Some firms simply outcompete their rivals because of superior management or other causes. Another argument long associated with Joseph Schumpeter, is that larger firms exhibit superior inventive and innovative performance. However, as Asch (5:136) points out, there are other explanations beyond size-related efficiencies for the existence of large firms and high concentration. Firms may have colluded to reach their position (concentration may be viewed as a manifestation of collusion as well as vice versa). Or, as Mancke (57) points out, the relation between profits and a concentration measure may reveal nothing about market power or efficiency. Mancke suggests that a correlation between the size distribution variable and profits results from a stochastic process of random events. In other words, the firm was in the right place at the right time; they were lucky. Demsetz (29:1) describes efficiency as a differential cost advantage resulting from scale economies, downward shifts in marginal costs, and/or superior products and marketing techniques produced by a skilled and innovative management. Demsetz believes firms reach positions of power because they are more efficient and Mancke because they are lucky, not by the deliberate acquisition of market power.

Porter (78:214) points out that market power results from the presence of entry barriers and from other structural characteristics (such as concentration) that lead to the recognition of mutual independence so that interfirm rivalry is held short of the competitive ideal. The benefits of market power should be shared equally by all firms in an industry in proportion to their sales. This is the conventional view. However, several authors disagree with this shared asset theory of monopoly power. Demsetz (29) found that the profits of smaller firms are not higher in concentrated industries than they are in unconcentrated ones, while the profits of larger firms are. This work was later replicated by Carter (12) and Round (81), with Australian data. Demsetz (29) notes that concentration may lead to some collusion, but the concentration itself is a result of the superior efficiency of leading firms. Porter (78:226) offers the theory of strategic groups as a possible explanation for Demsetz's results. According to Porter, mobility barriers should protect the leading firms that are enjoying scale economies or other efficiency-related advantages from the pressure of intergroup rivalry. Mobility barriers protect the relatively successful firms from incursions by other firms. The less efficient firms would want to replicate the strategies of the more efficient ones, but the latter firms are protected by mobility barriers (78:226). Thus, Porter's explanation for Demsetz's results rests squarely on market power considerations, refuting Demsetz's arguments.

Clarke and Davies (18) have recently developed a theoretical test to see if the positive relationship between concentration and profits can be attributed primarily to market power considerations, or if both high concentration and profits are caused by the superior efficiency of larger firms. Assuming an industry of N firms producing a homogenous good, marginal costs are constant for each firm across the relevant output range but varies across firms. Clarke and Davies (18:277-278) extend the work of Cowling and Waterson (25) to develop the following relation:

$$\frac{\pi}{R} = \frac{1}{N\eta} + \frac{(1-\eta N)^2 V_c^{\,2}}{N\eta}$$

where $\frac{\pi}{R}$ is the industry average price-cost margin (or profit-revenue ratio if there are no fixed costs), N is the number of firms in the industry, η is the industry price elasticity of demand, and $V_c^{\,2}$ is the coefficient of variation of marginal costs, a measure of the cost (efficiency) differentials between firms. They further develop the expression:

$$\frac{\pi}{R} = \frac{H(1-\alpha)}{\eta} + \frac{\alpha}{\eta}$$

where H is the Herfindahl index of concentration and α is an estimate of the degree of implicit collusion or market power inherent in the market. As α tends to 0, the Cournot case is approximated, while perfect collusion is approach as α tends to 1 (18:279). The first expression estimates the price-cost margin in terms of demand and cost conditions represented by N, η, and V_c^2 when $\alpha = 0$. The second expression estimates price-cost margins across a spectrum of collusive behavior (18:280). Clarke and Davies (18:284) claim this model permits a decomposition of profitability into its two component parts: market power and efficiency. The first equation gives the "efficiency" component of profitability. The second equation yields actual profits when some degree of collusion ($\alpha>0$) is present. The difference between this and the figure from the first equation is the "abuse" or market power component of profitability. Of course, α must be estimated to affect this decomposition. Clarke and Davies (18:279) recommend using firm level data on market shares and mark-ups within each industry to estimate α using the following expression:

$$C_i = P\{1-\frac{1}{\eta}\left(\frac{X_i}{X} - \frac{X_i}{X} + \alpha\right)\}$$

where C_i is marginal cost for the ith firm, P is price, X_i is the profit maximizing output for the ith firm, and

$X = \sum_{i=1}^{N} X_i$. Clarke and Davies' theoretical work has not yet been verified empirically, because many or most of these variables would be very difficult to develop in the practical sense.

Allen (3) recently developed the only known empirical test for decomposing the profit effects of market power and efficiency. He uses a fairly traditional industry based model with two additional independent variables. Following Newman (72) and Porter (78), Allen develops a measure of strategic group concentration within the oligopoly core (I), calculated as the value of shipments of the four largest firms divided by the value of shipments of the fifth through eighth largest firms (3:4). Allen captures the relative efficiency of large firms (CAR) through a measure of the cost advantage of the four largest firms relative to the next four firms (2:4). CAR was calculated as the average value added per employee for the largest four firms divided by the average value added per employee for the next four largest firms. Allen notes that CAR may be limited by intra-industry differences in wage payments or inflated value added output measures caused by group specific market power in the larger group. Allen looks at these two influences through further regression analysis and concludes that, while both influences exist, the relative effects are slight and CAR remained a suitable measure of the relative efficiency of large firms (3:6). He compares regression results for the conventional model, a model with

I in place of C_4, and a model with both I and CAR in place of C_4. The second model showed a three-fold increase in the impact of market power on profits and the explanatory power of the model increased 22 percent, indicating that I is a better market power measure than C_4 (3:7). The I regression coefficient was three times as large as the CAR coefficient in the third model, indicating that market power's impact on profits was about three times efficiency's impact. Allen's work therefore validates the conventional view that market power is the dominant influence in the concentration-profits relationship.

A wide variety of approaches have been used to explore the nature of the structure-performance relationship. The traditional theoretical model of industrial profitability includes a vector of variables that describe the size distribution of firms as a measure of collusive opportunity, a vector of variables describing entry barriers, and a vector of measures describing the demand side of the market. The importance of each possible measure must be weighed against the difficulties of constructing such a measure with available data. There are also theoretical disagreements about which measures are more appropriate. In addition to model differences, there are significant differences in the types of data that are employed. The two major types of studies are industry based and firm based. Industry based studies measure data at the industry level across many industries. Firm based studies measure data at the corporate level across many firms, either within a particular industry or across many industries. The major unanswered question that this study attempts to address is the relative roles of market power and efficiency in the production of profits, particularly in the defense sector.

TABLE 1

Survey of Studies of the Concentration-Profits Relationship

Study	Profit Measure	Structural Variables	Coverage	Period	Main Findings
Comanor & Wilson 1967	Average After-tax return on equity for firms with assets > $500,000	C4 and C8 Advertising-Sales Ratio Sales Growth Scale Economies Proxy for optimal plant size Capital requirements of such plants	41 U.S. consumer goods, IRS minor industries with assets > $500,000	1954-57	Concentration-profits relationship is positive, significant until scale and capital requirements introduced, then sign becomes variant and relationship insignificant. Advertising intensity was associated with rates of return.
Hall & Weiss 1967	After-tax return on equity, individual firms	C4 and C8 Asset Size Output Growth	341 Large US Firms from Fortune 500 industries	1956-62	Concentration-profits relationship was positive, significant but SIZE was more closely associated with rate of return.
Miller 1967	Average After-tax return on equity	C4, C8-C4, C20-C8, and C50-C20	106 US firms primarily to IRS manufacturing industries	1959-62	C4-P relationship positive, significant, but C8-C4 produces a negative, significant relation, others not significant. Only top 4 firms successful in raising industry profits.

Study	Profit Measure	Structural Variables	Coverage	Period	Main Findings
Collins & Preston 1969	Industry Price-Cost Margins	C4 Asset Size Index of Geographical Dispersion Capital-Output Ratio	All US 4 digit industries	1958-63	Weak, positive, significant C-P relationship for consumer goods, not significant for producer goods.
Imel and Helmberger 1971	After-Tax return on sales minus a deduction for implicit returns to equity capital	C4, advertising-sales ratio, R&D expenditures, relative firm size(market share/CR), average year end assets	99 US firms in food and tobacco industries	1959-67	Both C4 and relative firm size both significantly, positively related to profits
Gale 1972	After-tax return on equity, individual firms	Market share estimates dummies for high meduim, & low CRs and their interactions, sales growth, sales	106 US manufacturing firms	1963-67	Market share positively associated with rates of return. Effect is greater for large firms, high concentration, or moderate growth.
Shepherd 1972	After-tax return on equity	Market shares, C4-MS, asset size, advertising sales ratio, growth	231 Large US firms from Fortune 500 industries	1960-69	Rates of return closely associated with market share, less closely with concentration and entry barriers.
Shepherd 1972	Average industry price-cost margins	C4, SIZE(Shipments), advertising intensity, sales growth, capital intensity	All US 4 digit manufacturing industries	1963-69	Margins consistently associated with concentration and advertising intensity
Demsetz 1973	Rate of return on assets	C4, Asset Size	All US firms primary to IRS minor manufacturing industries	1963	Concentration increases profits of large firms (over $50 million in assets) but not small firms

Study	Profit Measure	Structural Variables	Coverage	Period	Main Findings
McFetridge 1973	Average industry price-cost margins	Herfindahl index, C4, C8 inverse of # of firms accounting for 80% of industry output, regional market dummy, consumer goods dummy, growth, advertising-value added ratio, capital-output ratio	43 Canadian 3 digit manufacturing industries	1965-69	C-P relationship positive, significant for all concentration indexes, H most strongly associated. More significant for consumer goods than producer goods.
Khalilzadeh-Shirazi 1974	Average industry price-cost margins	C5, minimum efficient plant scale, sales growth, product differentiation dummy, capital-output ratio, import-sales ratio, export-sales ratio, foreign control dummy	119 UK 3 digit manufacturing industries	1963	Positive, significant C-P relationship, consistent with US studies
Caves, Khalilzadeh-Shirazi & Porter 1975	Average after tax return on equity for firms with assets > $500,000	C4, C8, advertising-sales ratio, sales growth, capital requirements(MES-industry assets-sales ratio), CDR, regional dummy, growth-C8.	42 US consumer goods, IRS minor industries with assets > $500,000	1963-65	Large minimum efficient scales generate significant entry barriers only when the cost disadvantage of small scale plants is significant
Lustgarten 1975	Average industry price-cost margins	C4, Capital output ratio, advertising expense, four measures of buyer concentration: Buyer concentration ratio (BCR), Relative buyer firm size(RBFS), average annual firm purchases(AAFP), and buyer disperions(DSPH).	327 US 4 digit manufacturing industries	1963	Seller concentration was positively associated with margins, buyer concentration was negatively associated with margins. BCR and AAFP more robust. Impact of buyer concentration higher with high seller concentration.

Study	Profit Measure	Structural Variables	Coverage	Period	Main Findings
Round 1975	Average rate of return on assets	C5, Firm Size	33 Australian manufacturing industries	1971-72	As concentration increases, profits of large firms increase more than profits of small firms, verifying Demsetz's results
Stonebraker 1976	Rate of return on assets	Relative industry growth rate, firm failure dummy, the % of small firm profit rates below competitive returns. Average distance below this level	Nearly 1000 firms from 33 US manufacturing industries	1955-68	High profits highly associated with high entry risk. High risk of entry raises profits for industry.
Strickland & Weiss 1976	Industry Price-cost margins	Capital-output ratio, growth, C4, geographical dispersion index, advertising-sales ratio, scale economies proxy. Uses simultaneous equations, the other two for C and AD/S	408 US 4 digit manufacturing industries	1963	Advertising increases with margins. ADV-C relationship forms inverted U, reaching peak at C4=.49. Advertising's effects on margins negligible.
Cowling & Waterson 1976	Average rate of return on sales	Herfindahl index, C4, durable good dummy, capital-output ratio, union density	94 UK minimum line heading industries	1958, 63 & 68	Changes in concentration, measured either with C4 or H, results in significant increases in margins allowing for the lag. H performs better, durable goods show higher associatio

Study	Profit Measure	Structural Variables	Coverage	Period	Main Findings
Hart & Morgan 1977	Industry Price-Cost Margins	C5, Capital-output ratio, sales growth, advertising-sales ratio, median firm size, import-sales ratio, the number of firms in industry	113 UK manufacturing industries	1968	Weak, positive relationship between concentration & profits in static sense. No evidence for positive association between proportion changes in profitability and like changes in concentration, refuting Cowling & Waterson.
Kwoka 1977	Industry Price-Cost Margins	"Dominance Index," Number of firms in industry, capital-output ratio, geographical dispersion index, sales growth, consumer good dummy	332 US 4 digit manufacturing industries	1967	Margins higher in industries dominated by one or two firms, rather than in industries with equal size firms or large concentration ratios, regardless of share distribution.
Carter 1978	Industry Price-Cost Margins	Capital intensity top 4 firms, capital intensity next 4 firms advertising intensity top 4 firms, advertising intensity next 4 firms, concentration coefficients for both groups	410, 408, & 440 US 4 digit manufacturing industries	1963, 67&72	Concentration reflects superior large firm efficiency, corroborating Demsetz
Newman 1973	Industry Price-Cost Margins	Capital-output ratio, sales growth, C8, Herfindahl index constructed over shares of strategic groups, vertical interaction dummy	34 US 4 Digit manufacturing industries selected for similar entry barriers (producer goods)	1967-69	Heterogeneity of strategic groups lowers profit by lowering communication and opportunity for concensus.

Study	Profit Measure	Structural Variables	Coverage	Period	Main Findings
Kwoka 1979	Industry Price-Cost Margins	Capital-output ratio, sales growth, geographical dispersion index, consumer good dummy, MCDR-AN interaction of CDR and share of mid-point plant size, C4, Herfindahl index, market shares (first largest(S1), second largest(S2), etc)			Large market shares for two leading firms most decisive for raising margins, more so than C4 or H. Minimum efficient plant size and cost disadvantages of small scale entry also relevant.
Martin 1979	Industry Price Cost Margins	Capital-output ratio, growth, C4, regional industry dummy, advertising sales ratio, minimum efficient plant size, cost disadvantage ratio, buyer concentration ratio, durable goods dummy, import sales ratio, consumer demand sales ratio. Uses simultaneous equations, the other two for C & AD/S.	209 US 4 Digit industries	1967	Entry barriers influence profits only through their influence on concentration
Porter 1979	Average after tax return on equity for firms with assets > $500,000	C4,C8,industry growth, AD/S, MES, capital requirements, regional industry dummy, convenience goods industry dummy, average leader share(leaders account for 30% sales) # firms in leader and follower groups, relative leader group market share	38 US 3 Digit consumer goods industries firms excluded with less than $500,00 in assets	1963-65	Strategic group arrangement significantly affects profits. Mobility barriers protect successful firms

Study	Profit Measure	Structural Variables	Coverage	Period	Main Findings
Kwoka 1981	Industry Price-Cost Margins	C1,C2,...C10, capital-output ratio, geographical dispersion index, sales growth, share of midpoint plant size, consumer good dummy	314 US 4 Digit Industries	1972	Margins best determined by C2, not other C ratios.
Geroski 1981	Industry Price-Cost Margins	C5, AD/S, Capital intensity, import-sales ratio, export sales ratio, sales growth, diversification index	52 UK minimum line heading industries	1968	Margins negatively associated with import intensity, unrelated to diversification. C-P relationship varies sign with amount of concentration
Paloulatos & Sorensen 1981	Industry Price-Cost Margins	C4, Capital-output ratio, AD/S, Price elasticity of demand, regional dummy, scale economies dummy, import sales ratio, export sales ratio, sales growth simultaneous equations, also A/S and C	47 US food processing industries at 4 digit level	1967	Price elasticity of demand had important impact on profits. Advertising significantly influence both profits and concentration.
Bradburd & Caves 1982	Industry Price-Cost Margins	Capital-output ratio, AD/S, C4 divided by one plus ratio of imports to domestic shipments, importance variable measuring demand of output by other industries weighted PCM's of buying industries, expected growth, unexpected growth	77 US producer goods industries	1972	Unexpected growth significantly associated with margins, expected growth less so.

Study	Profit Measure	Structural Variables	Coverage	Period	Main Findings
Gale & Branch 1982	Return on Investment (Before tax profits divided by invested capital	Market share, C4	Above 2000 line of business units from SPI's PIMS problem	1970-79	Market share overwhelms concentration as a structural determinant of profits-market share associated with profits via efficiency rather than concentration via market power
Allen 1983	Industry Price-Cost Margin	C4, # of companies in industry, sales growth, capital-output ratio, consumer goods dummy, geographical dispersion index, value of shipments for top 4 firms divided by value of shipments for next 4 firms(I), average value added per worker for top 4 firms divided by same measure for next 4 firms	297 US 4 digit industries	1972	Market power (I) dominates efficiency (CAR) in the C-P relationship, by about a 3 to 1 margin.

III. Structure-Performance Relationships In The Defense Sector

This chapter will focus on the structure, conduct, and performance of the defense sector. First of all, it should be noted that defense spending has a notable impact on the economy. According to the 1983 Economic Report of the President, national defense purchases totaled $153.3 billion in 1981. This made the Pentagon the largest single purchaser of goods and services in the economy. In fact, the military has been the largest single source of demand in our economy for the last thirty years (28:6). After adjusting for inflation, and excluding the Vietnam War buildup, the defense budget has remained relatively constant since the Korean War. Excluding the dramatic increase during the Vietnam War and the recent increases under the Reagan Administration, military spending has remained around $100 billion in 1977 dollars (36:23). When viewed as a percentage of the gross national product (GNP), the military's share has dropped from about ten percent of the GNP in the 1950's to an average of six percent during the 1970's (28:7).

Structure of the Defense Sector

The structure of the defense sector deviates significantly from traditional free market theory. The defense marketplace consists of a monopsonist on the demand side (the Department of Defense) facing an oligopoly on the supply side (a relatively small number of primary contractors). Because it is not a perfectly competitive market, the defense sector behaves as a traditional oligopoly, with one important difference. In a traditional oligopoly or monopoly market, the buyer and seller are still essentially in adversary positions, but in the defense market the interests of the buyer and seller coincide much more closely. According to Jacques Gansler (36:29) this causes the government to be relatively insensitive to price.

On the buyer side of the market, the government funds weapons programs because of a military requirement for a more advanced system of technological opportunity for greater capability. America's defense strategy has been to maintain a technical superiority of military hardware over the Soviet Union. As such, most weapons systems are developed near the leading edge of technology with price as a secondary design characteristic. Of course, technological uncertainties increase risk for the seller and promote instability in the acquisition program because one cannot be certain how long it will take or how much it will cost to overcome these difficulties. In addition, it becomes more difficult to negotiate a selling price when the product to be developed is not yet well defined.

The Congress decides how much to spend each year on defense, not the buyer or the seller. The annual budget process causes uncertainty in the defense sector's long range planning because most programs are funded only one year at a time. Shifting political winds may cause a weapons system to be cancelled or curtailed. Programs may also be stretched out to accommodate all desired programs within a fixed budget (10:63-65).

These weapons programs can be very costly. About 20 acquisition programs now consume over 40 percent of DOD's procurement dollars each year (36:32). These few, large programs make individual contract awards extremely important to the contractor. Adams and Adams (1:283) argue that contracts are awarded so that all the major defense firms are allowed to survive, for the good of the nation's long term defense capability, although such a policy is nowhere explicitly stated by the government. According to Marfels (60:411), a contractor in need of a contract often "buys in" to a program by submitting an unrealistically low bid, which is then revised upward after the contract is awarded.

The synergistic relationship between the government and defense suppliers is enhanced by the government practice of sharing capital equipment and plants with the contractors. According to Gansler (36:35), the mix of public and private production facilities varies among industries. For example, the government owns about two-thirds of the production facilities in the munitions and strategic missiles industries, about one-third in the aircraft industry, and none in the shipbuilding industry (36:35). The government wants to keep its plants busy to justify their existence and achieve efficiency, and therefore much defense production is done in government facilities.

On the supply side of the market, the defense sector consists of about 22,000 prime contractors and about 100,000 subcontractors or parts suppliers (60:413). A prime contractor is a firm that deals directly with the government on large, usually systems-level procurements. A subcontractor supplies some segment or subsystem of the procurement directly to the prime contractor, so they usually do not deal directly with the government. A supplier firm sells parts and raw materials, usually to sub- or prime contractors. At the prime contractor level, the government is more heavily involved in providing production facilities. Also, government procurement regulations and documentation requirements are more widely applied at this level (29:5). In fact, the administrative paperwork imposed by the government has been widely recognized as a significant impediment to efficiency and progress in a weapons program, a process devouring many person-years of effort (10:58-72; 66:15; 65:63). The subcontractors and parts suppliers are required to supply their own facilities and capital. According to Gansler (36:5), their profits are generally lower (especially when measured against investment) because they must deal with the prime contractor, who is presumably not as insensitive to price as the government. The subcontractor or supplier is also less well able to handle the government's documentation requirements and do not receive the same kind of contracting benefits that the prime contractors receive from the government (22:13). For example, these lower level contractors do not receive cost reimbursement type contracts with the government or progress payments for work accomplished (these terms to be explained later), as the prime contractors sometimes do.

Gansler reports an aggregate C4 concentration ratio of about 20 percent for all the defense industries that make up the defense sector, which is actually lower than most non-defense manufacturing industries (36:36). However, the relevant concentration ratios are at the product or market level, where C4 ratios of 80, 90, or even 100 percent are common for defense industries (see Table 2). At this level most sections of the defense sector are heavily concentrated (36:43). These concentration levels can be even higher at the subcontractor or supplier level. For example, the 1966 C4 ratio for propellers was 98; for special dyes and tools, 97; for gas cylinders, 100 (36:44). Monopolies exist at the component level for certain products. Gansler (36:36) attributes this high concentration to the large size of individual programs, which makes the number of individual programs relatively small, and the degree of specialization required for defense business. There are also significant entry barriers present in the defense

Table 2. Concentration Ratios in the Military Market, Fiscal 1967

	CONTRACT AWARDS (MILLIONS OF DOLLARS)	PERCENTAGE OF CONTRACTS	
		TOP 4 FIRMS	TOP 8 FIRMS
SURVEILLANCE AND DETECTION SATELLITES	$ 236	100	100
NUCLEAR SUBMARINES	211	99	99
FIGHTER AIRCRAFT	2,164	97	100
JET AIRCRAFT ENGINES	1,892	93	99
SHIPS AND PARTS	1,391	67	77
COMMUNICATIONS SYSTEMS	224	56	81

Source: Adapted From Jacques S. Gansler, The Defense Industry, Cambridge, Massachusetts: MIT Press, 1980.

sector (to be discussed shortly).

Military expenditures, and procurement buys expecially, declined in the second half of the 1970's from their Vietnam levels. The major contractors were able to maintain their share of the defense business by acquiring other defense firms, both vertically and horizontally, but each plant was operating less and less (36:39). This results in a less efficient market operation because the older, less used plants are not replaced by more modern and fully employed plants (36:39). A general decline in defense business has therefore contributed to large excess capacity in the defense sector.

In order to maintain their overall corporate growth, many defense firms have shifted more of their operations into the civilian sector. Gansler states that the top 25 defense contractors went from 40 percent of their business in defense in 1958 to about 10 percent in 1975 (36:39). For example, firms like Raytheon, TRW, and United Technologies were almost entirely in defense during the 1950's and 1960's, but by 1977 all three did less than 40 percent of their business in defense (36:289; 30). According to Gansler (36:41), most of the large defense contractors have diversified to the civilian through corporate acquisitions. This corporate diversification significantly reduces the bargaining power of the government and increases the firm's flexibility.

As mentioned earlier, the defense sector is characterized by very high entry barriers. These barriers limit the ability of potential firms to enter the defense market. Barriers vary by industry but there are a number of common traits running through the entire defense sector. Gansler (36:46-48) lists the following barriers:

Marketing Problems: Defense is a unique marketplace. Most selling is done directly, so there is little need for advertising. To compete in the defense sector, a firm must understand how the government operates, and this requires extremely specialized marketing skills.

Inelastic Demand: A potential entrant in the defense market cannot be sure the government will buy its product, even if it lowers prices, since demand is essentially established by Congress.

Market Environment: Political, technical, and funding instabilities, coupled with present excess capacity, discourages potential entrants.

Brand Loyalty: The individual services feel a good deal of allegiance for the firms that have traditionally supplied their needs. The different services have established preferences for dealing with certain suppliers.

High Technology: Since defense contracts are awarded based primarily on improved performance, a potential entrant cannot simply use existing technology to duplicate an existing system at a lower cost. The new firms must possess the capability to develop new technologies for an improved product. This requires a highly skilled, specialized labor force, possessing a great engineering and scientific capability, which is presently in short supply. A large R&D capability is also required to compete successfully.

Capital Requirements: Expensive, specialized equipment is required in the defense sector. Since the government owns about 30 percent of this equipment at the prime contractor level, this creates a significant barrier. In addition, the financial community is reluctant to lend in the high risk defense sector, making capital formation difficult.

Political Barriers: Congress can be expected to take steps to protect defense firms in their district.

Security Clearance: The requirement for security clearance is expensive and time consuming, but usually necessary.

Conduct of the Defense Sector

The conduct of the defense sector is also unique. Walter and William Adams have described the relationship between buyer and seller as a closed system not unlike the relationship between the old, great mercantilist trading companies and their governments (1:279). The trading companies and the defense firms are both examples of instruments chosen to advance a public purpose, and as such, were given exclusive privileges and protection by the government. But Gansler (36:72) points out that the close relationship and commonality of interest between government and industry at the aggregate level is less pronounced than generally believed for individual procurements. The appearance of mutually beneficial joint ventures is carefully avoided in the highly visible defense market. Public accountability and regulation are therefore important aspects of the defense market. All of the government's decisions and all the industry's records are subject to review by the Congress and the public (36:72). When an abuse is discovered, more regulations are applied to the industry, usually without considering the impact of the entire industry.

The acquisition of a weapons system generally starts with competition for the research and development contract. The contract award is based primarily on technical ability, with price as a secondary concern. The proposals are evaluated by the government in a source-selection process that can run as long as a year (36:74). Firms are often willing to "buy in" to a program by taking a loss on the smaller development contract so they can secure a sole-source status on the larger production contract that follows. Development contracts almost always contain some kind of cost-reimbursement provision (more on contract types later), so the only dollars they risk are profit dollars; all costs, including overruns, are paid by the government (36:75). The firms also know that costs will grow during the course of the program, and the pricing of these costs will be accomplished after all competition with other firms has ended. The contractor is also motivated to propose a large number of technical changes once the program is in the development stage, so that these price changes will have to be negotiated. These changes usually continue through the production stage, reducing smooth, efficient production (36:75). The contractor is actually encouraged to be inefficient through this process.

Since most of the production awards go to the contractor who receives the development contract, and because a lot of development work results from contractor changes or cost growth, and because these contracts are all awarded sole-source, a major share of DOD contract dollars are awarded without benefit of competition (36:75). Although DOD regulations state explicitly that business by formal price competition is preferred, 92 percent of the dollars are spent through negotiation, without competitive bidding (36:75).

Naturally, the competition for a development contract is intense. The government is in a strong bargaining position as long as a commitment to a single supplier has not yet been made, and can play the contractors against one another to extract promises of high performance, early delivery, and low cost. But once a supplier has been chosen, the relative bargaining power of the two parties shifts strongly in favor of the contractor. Since the acquisition cycle, from initial research to delivery for a major system now runs 10-18 years (65:60), the sole-source supplier's position becomes more powerful as time goes on. This occurs because no close substitute would be available from another firm in a reasonable period of time.

The major firms involved in competition for a development contract must deal with a great deal of long term uncertainty. Firms must show they have the skilled labor and specialized equipment available before they can expect to win the contract, but if they lose, all of this capability will go unused (36:78).

Performance of the Defense Sector

The performance of the defense sector has been disappointing in many respects. One important failure of the market has been the rapidly escalating price of defense equipment. After adjusting for inflation, military equipment has been rising at about 5 percent per year for the last three decades (36:83). This means that equipment costs 3 to 5 times as much as the previous generation, which results in lower procurement rates, reduced military capability, and inefficiently low production rates (36:83). In addition, product quality has often fallen short of original specifications (1:280). In contrast, civilian durable goods and equipment have been going down in constant dollar price, and product quality has generally risen (36:83). One reason for this disparity is that excess capital and labor capacity can be charged against contracts in the defense sector when these production factors are not truly required for efficient production. Defense industries have greater excess capacity than civilian manufacturing (36:84). For instance, the aircraft industry was operating at only 55 percent of capacity in 1980 (36:84), a year in which all of manufacturing operated near 70 percent of capacity.

Market power may also be a factor in the poor price performance of the defense sector. According to traditional oligopoly theory, high defense prices are likely to be directly attributable to high concentration in the defense sector. This would be especially true at the subcontractor or supplier level where concentration is very high for certain products. Firms in industries with high concentrations would be expected to exercise their market power to raise prices and profits.

Other possible reasons for the high price of defense goods can be found in the types of contracts used by the government. The first of the two major contract types is the cost reimbursement contract. Cost contracts allow the firm to recover all allowable and reasonable costs from the government. As noted earlier, defense firms are motivated to raise costs when cost reimbursement contracts are used because profits are usually negotiated as a percentage of costs. The cost-plus-fixed-fee (CPFF) contract specifies a fixed dollar amount over costs to be paid to the firm. The cost plus incentive fee (CPIF) contract calls for negotiating a minimum profit, target profit, maximum profit, target cost, and share ratio between the firm and the government. If the firm completes the contract under the target cost, it may add to its minimum profit a certain percentage of the difference between its target and actual profit, according to its share of the negotiated share ratio. (For example, a 40/60 share ratio means the firm would receive 60 percent of the difference.) If the firm's costs rise above the target level, the government absorbs a share of the extra costs, according to the share ratio, up to the point where the firm's profits fall to the minimum profit level, at which point the government absorbs all additional costs. This provides an incentive for cost controls, at least to the point of the stipulated maximum profit, assuming target costs can in fact be met. In short, the government assumes most of the cost risks in either type of cost reimbursement contract. Costs are generally reimbursed by the government as they are incurred. Cost type contracts are preferred by the industry for high risk programs.

The second major contract type is the fixed price contract. In this contract, the firm assumes most of the program risks. The firm fixed price contract (FFP) calls for a set price not subject to change unless the government approves changes in the contract. This type of contract naturally promotes cost efficiency in the firm and involves only minimal administrative costs. The fixed price incentive fee (FPIF) contract calls for the negotiation of a share ratio, target cost, target profit, and a point of total assumption (PTA), where the contractor begins to assume all risk. If the firm completes the contract under the target cost, it receives the target profit plus a percentage of the difference between actual and total costs, according to the share ratio. If the firm is over its target cost, the government pays a percentage of the cost overrun, according to the share ratio, up to the program cost associated with the PTA, at which point the contractor must absorb all the additional costs. The firm is generally paid on delivery for these types of contracts. Fixed price contracts encourage cost controls by the firm because the company assumes most of the program risks. If the risk factor is considered manageable, most firms prefer fixed price contracts, because there is no upper limit on profits. Also there is generally less government monitoring and interference because costs need not be watched so closely by the buyer. There has been a gradual transition from cost to fixed price contracts since the late 1960's. According to a recent study of the defense industrial base commissioned by the Office of the Secretary of Defense, the Profit '76 report, the 1975 dollar breakdown of all defense contracts by type (for contracts over $1 million) was as follows: CPFF, 16%; CPIF, 15%; FPIF, 22%; and FFP, 46% (31:V-11).

The defense market has not been an especially attractive place for American industry. According to a 1980 Congressional study (22), the economic performance of the defense industrial base is deteriorating. One of the reasons is that, while the United States still leads the world in productivity, it is now dead last in productivity growth among all free world industrialized nations (77:11; 78:41). Further, the productivity growth of the defense sector is lower than the overall manufacturing sector (22:11). A major reason for slow productivity growth is a relative lack of capital investment. Capital investment in new technology, plants, and equipment has lagged in the defense sector, because of unfavorable contracting and tax policies, and because the government supplies capital facilities (although not all that is required) to prime contractors in many instances (22:11). Consequently, the defense sector is equipped with old, outmoded plants and equipment. The defense sector by nature is highly capital intensive. The return on investment in the defense sector is too low to attract and retain capital (96:40). In today's capital-starved industry, defense companies have to borrow funds in competition with the Treasury and commercial ventures with lower risk markets and very often, higher profits. However, the high interest rates on borrowed capital have not been recognized until very recently (31:IX-23) by the government as an allowable cost on defense contracts. The slow-rates of capital equipment depreciation allowed by law until very recently (31:IX-29) also discouraged investment. Despite defense acquisition regulations that require that program risks be considered when negotiating target profit levels, the industry sees a "mindset" on the part of the government of around ten percent as an acceptable profit (91:42). Since realized profits in the defense sector typically fall to about half the negotiated profit, this ten percent "mindset" results in lower profits for the defense firm compared to the commercial firm (31:IX-9). The industry is reluctant to invest in capital improvements unless there is some assurance these investments are related to stable programs. Programs funded on low cost estimates, high risk technology, or politically unstable weapons systems inevitably lead to funding stretchouts that adversely impact on the contractor's ability to recover these captial investments (96:42). Also, the prevalent practice of single year buys by the government forecloses the possibility of realizing the economies of scale possible with large scale buys. The contractor cannot buy materials in economic lot sizes because they cannot be sure of continued funding year by year.

Profits is another measure of economic performance. The Profit '76 (31) study reviewed the profits of 64 defense oriented companies with 147 profit centers averaging an aggregate total of $15.5 billion annually in government business from 1970 to 1974. Pre-tax return on sales, the profit criterion used by DOD for profit negotiations, averaged 4.7 percent over the five year period (31:IX-7). Pre-tax return on sales averaged 4.7 percent for fixed price contracts; 4.3 percent for cost type contracts (31:IX-7). The contractor who was willing to assume the greater risks associated with a fixed price contract earned very little additional profit on the average for taking such risks. The negotiated, or target profit averaged 8.8% for all DOD contracts, which indicates substantial erosion in profits during contract performance (31:IX-9). Gansler attributes this erosion to low contractor bids, or "buy ins", technical or scheduling problems, changes imposed by the government but not fully compensated, or disallowed costs (36:86).

The Profit '76 study compared this performance with the profits gathered by a Federal Trade Commission (FTC) sample of 5000 manufacturing firms producing average annual aggregate sales of $450 billion over the same five year period (31). Pre-tax return on sales averaged 6.7 percent. Gansler cites the lack of regulation, accountability, and renegotiation as partial explanations for this higher profit performance in the civilian sector (36:86). A structural explanation advanced by Gansler (36:86), and Lustgarten (55:128), among others, is the use of countervailing, monopsonistic buyer power by the government to control sellers' profits below levels otherwise attainable. As noted earlier, the government's power as a monopsonist is most strong before a sole-source supplier is selected. Lustgarten (55:129) has shown that the impact of buyer concentration on seller price-cost margins is greatest where seller concentration is high. This makes the defense sector particularly susceptible to monopsonist power, at least prior to the contract award.

Since return on investment is a key factor in the allocation of resources, the Profit '76 study also compared this profit measure for the two data sets (31:IX-12). They defined return on investment as the return on total assets, less government progress and advanced payments in the defense sample. Progress payments are paid by the government to the firm for costs incurred as work progresses. Advanced payments are paid before the costs are incurred. The FTC average was 10.7 percent; the defense average was 13.5 percent (31:IX-12). The depreciated value of government supplied capital equipment and facilities was then added to the assets of the defense firms to control for this factor. The return on investment average for defense firms only decreased from 13.5 percent to 13.0 percent (31:IX-13), indicating the impact of government owned facilities on this profit measure was fairly small. The probable reason for this small decrease in the defense sample's return on investment is that the amount of government furnished capital varies widely among defense industries and is limited to the prime contractor level.

Gansler notes little disagreement about the lower return on sales averages for defense firms (36:86). He cites considerable disagreement over the return on investment averages, however. A Forbes Magazine study showed defense sector return on equity and return on total capital to be higher than total United States industry averages (36:87). A Logistics Management Institute study concluded that the average defense firm's return on investment is lower than a comparable civilian firm (36:87). Douglas Bohi (9:728) studied this issue and concluded there was no significant difference in profitability between defense profits and nondefense profits.

The Profit '76 study found wide variations in return on investment for the defense sector. Large defense firms had much higher returns than small defense firms (36:87). Gansler suggests the size distribution of the defense sample may drive the return on investment results (36:87). The barriers to entry for the defense sector definitely point to the advantages of size. The Schumpeterian argument of superior innovative and inventive performance in large firms may play a role. The ability to use government furnished capital facilities favors the large firms because they tend to be the prime contractors. Or, as Demsetz argued (29:1), the higher profits of the large firms may be caused by their superior efficiency.

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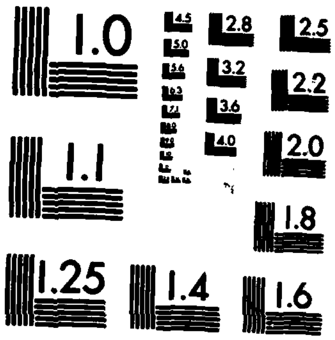

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Models of the Defense Sector Structure-Performance Relationship

Only a few studies of the structure-performance relationship have dealt specifically with the defense sector. More typically, studies have specifically excluded firms with high military sales from their data (for example, see Shepherd, 85:28). Adams and Adams (1) examine the defense industry on a strictly theoretical basis. They feel that the monopsony power of the government is effectively neutralized by an oligopolist group of sellers that collude to prevent technical and cost information from being revealed to the buyer (1:281-282). They suggest that defense sellers face price-insensitive demand, permitting them to survive despite alleged inefficient performance, because the government has erected an array of entry barriers that artificially maintain their market power. They advocate that the government lower entry barriers by contractually allocating more risk to the seller, reducing government furnished capital, and taking other similar actions to reduce or counteract sellers' market power.

Garber and Poirier (37) were among the first to seriously examine the structure-performance relationships within the defense industry. They built a firm based regression model to predict profits within the aerospace industry from 1951 to 1971. Profits were defined as return on assets, both before and after taxes. The predictor variables were real DOD procurement expenditures each year, real non-DOD space expenditures each year, a linear spline time dimension variable, and a series of dummy variables which identified whether or not the firm was one of eight giants of the industry (Boeing, etc.) (37:231-232). Garber and Poirier predicted that high levels of government spending would reduce excess capacity in the industry and thus reduce the need for any single contractor to be awarded a contract, which would translate into relatively greater bargaining strength and increased profits (37:228). They also predicted that war conditions would translate to a greater sense of urgency on the part of the government for equipment, which would again improve the contractor's relative bargaining strength. They found that the estimated coefficients of the DOD procurement variable were consistently negative, but statistically insignificant, an unexpected result they attributed to noise created by the unavailabilitv of a procurement figure that only included aerospace procurement (37:235). The estimated coefficients of the R&D and non-DOD space expenditures variables were both consistently positive and significant at the 10 percent level (37:235). The size of the space coefficient was many times larger than either the R&D or procurement coefficients, indicating that the aerospace industry enjoyed substantially higher profits on space related work (37:235). The dummy variables merely showed which firms were more profitable relative to each other. The time variable showed a significant upward trend in profits during the Korean War, a significant downward trend between the wars, and a positive but not significant trend during the Vietnam War (37:235).

Thus, it appears that Garber and Poirier's theories about the relative bargaining strengths of buyer and sellers as an important determinate of aerospace profits were correct, except for the DOD procurement variable. Their view that high levels of aggregate government spending would translate to greater bargaining strength for the contractors was untempered by the possibility that more defense business might mean lower overall profits because defense sales may be less profitable than commercial sales. Since Garber and Poirier discuss the effects of their predictor variables in terms of relative bargaining strengths, and not reduced costs, one may assume they are thinking about market power instead of efficiency as the driving force behind their model, but they are never clear about what structural forces they are trying to capture. Their model contains no traditional measure of market power or efficiency, which limits its usefulness. They did, however, make one of the initial attempts to model the structure and performance of the defense sector.

Beverly, Bonello, and Davisson (8) recently undertook another study of the structure-performance relationship of the defense sector, with particular emphasis on the aerospace industry. The combined firm data from Standard and Poors' Compustat data service with Disclosure, Inc.'s

Security and Exchange Commission form 10-K information (which is more complete than Compustat) to identify 106 prime contracting corporations and a comparable group of 145 control firms that sold little or nothing to the government (8:23). The prime contractors were defined as firms that sold at least 13 percent of their net sales to the federal government (8:23). The control group were firms with the same industry classification (SIC) codes as the prime contractors. There were a total of 31 SIC codes where there was at least one control firm and one prime contractor in the indicated SIC code (8:37). The authors ran a series of regression models to compare these two groups on the basis of profitability, production efficiency, working capital/liquidity management, inflation reaction, and product specialization. I will concentrate my review on the first two factors.

Beverly, et al., describe return on sales, return on assets, and return on equity as three possible measures of profit (8:32). Their definitions correspond to the ones given in Chapter 2 of this thesis. When they compared profit margins of the two groups industry by industry, they found that, overall, there was no consistent or significant difference in profits, no matter how they were measured (8:48-51).

Four efficiency ratios were formulated. A labor/output measure was defined as the number of firm employees/net sales, where net sales is defined as gross sales less discounts, returns, and allowances (8:33). This ratio attempts to capture the productivity of the firm's labor force by measuring the average sales created by each employee. A capital/employment ratio was formulated as the firm's net plant/number of employees (8:33). Net plant represents tangible fixed property (generally at cost) used in the production of revenue, such as land, building, and equipment minus accumulated reserves for depreciation, deletion, and amortization (23:IX-60). The capital/employment ratio measure the amount of capital available for each worker. A cost of sales ratio was defined as the cost of goods sold/net sales. The cost of goods sold represents all costs directly allocated by the firm to production, such as materials, labor, and overhead (23:IX-27). This ratio indicates how well the firm is controlling input costs. Finally, the capital-output ratio was defined as the ratio of net plant/net sales. This ratio attempts to measure the productivity of the firm's capital by measuring the sales created by each unit of capital.

The Beverly, et al., study found that the average labor/output measure for defense firms was lower than the control firms in 20 of the 31 industries, indicating that labor productivity is slightly higher overall in the defense group (8:40). I used their data to test and reject at the .1 significance level the hypothesis that the control firms had a higher median labor/output ratio with the Wilcoxon signed ranks test, which verifies their conclusion that labor productivity is lower in the control subset of their sample. Their study found the average cost of sales ratio higher for defense firms in 24 of 31 industries (8:37), indicating less efficient cost managment in the defense firms. I verified this conclusion by rejecting at the .01 significance level the hypothesis that defense firms had a lower median cost of sales ratio with the same test. Their average capital/employment ratio was lower in the defense sample in 20 of the 31 industries (8:40). I again verified this conclusion in the same manner, this time at .05 significance level. In 7 of the comparisons the defense firm had a higher ratio of capital per employee, together with a higher cost of sales ratio, indicating that certain defense industries are sufficiently unique (involving high technology parts and equipment) that a heavy capital/employee structure is required even though it does not lower the cost of sales ratio (8:41). The authors attribute the relative lack of capital investment in the defense structure to the uncertainty associated with the short contracting periods and the possibility of funding disruptions (8:41). The average capital/output ratio was lower in the defense firms in 22 of the 31 industries, probably for the same reasons (8:42). I also verified this conclusion at the .05 significance level in the same manner. It is interesting to note that the defense firms were more efficient than the control firms in terms of the labor/output and capital/output ratios, but less efficient in terms of the cost measure, the cost of sales ratio. This may be due in part to relatively higher wage rates in the defense firms. Beverly, Bonello, and Davisson did not pursue this possibility because of a lack of wage data on the Compustat data base (8:40).

Beverly, et al., then ran a series of stepwise regressions with firms from both groups included on a year by year basis (8:95). Their regression equation was:

$$\text{Profit} = f(\text{DEF, NSALE, NETPL, EMP, COGS, KO, LOR, CLR})$$

where DEF = Defense sales/total sales, NSALE = Net sales, NETPL = net plant, EMP = number of firm employees, COGS = cost of goods sold/net sales, KO = capital/output ratio, LOR = number of employees/net sales, and CLR = net plant/ number of employees (8:67). Profit was measured as return on sales (ROS), return on assets (ROA), or return on equity (ROE). DEF was rarely significant, but when it was, the estimated coefficients were very small and positive (on the order of .0005). The authors concluded there was no significant difference between prime contractors and the control group with respect to any of the profit measures (8:96). None of the three size related variables (NSALE, NETPL, EMP) were significant for any profit measure. With respect to ROE, COGS was consistently significant and negative and CLR was consistently significant and positive (8:96). When ROA was the dependent variable, COGS was again consistently significant and negative and KO was also very often significant and negative (8:105). For ROE, COGS was once again consistently significant and negative, while KO and LOR were also very often significant and negative (8:102). The major determinants of profitability for this sample turned out to be the efficiency elements, regardless of how profits were measured. The explanatory power of each model by year, the R^2 values, ranged from .01 to .19 for ROE, from .12 to .29 for ROA, and from .46 to .60 for ROS (Ref 8:96, 102, 105). The first two ranges are consistent with other firm and industry based structure-performance models, but the latter values for the ROS models are higher.

The major strength of the Beverly paper is that all the data basically comes from a single source, the SEC form 10-K data. This significantly reduces incongruities in the way the variables were measured. The SEC 10-K information from Disclosure, Inc., allowed them to quantify the percentage of defense sales divided by net sales so they could more accurately define the defense sector. This information also allowed them to construct a control group of firms in the same industries but without significant defense sales. This is a superior way to define the data bases. The major weakness of the paper is a lack of some measure of market power. The Beverly models do not account for the possibility that firms can exert market power to maintain prices above costs. Some measure of the size distribution of firms (C4, market share, etc.)

should have been included to account for this. A number of traditional control variables are also missing. For example, there is no accounting for systematic advertising differences or regional markets in the control group. There is also no growth measure. The inclusion of these variables would have required additional sources of data, which these authors were evidently unwilling to pursue.

Robert Allen recently examined the roles of efficiency, market power, and profitability in the defense markets (Ref 4) using the industry as the unit of observation. He employed a model previously developed to examine these same relationships in American manufacturing (Ref 3). The basic model is:

$$PCM = f(C4, NCO, KO, DISP, CDUM, GROW, CAR)$$

where PCM = price-cost margins calculated as value added minus payroll divided by net sales, C4 = 4 firm concentration ratio, NCO = number of companies in industry, KO = capital-output ratio (to account for interindustry differences in capital intensity), DISP = a geographical dispersion index to capture the effect of regional markets, CDUM = a dummy variable to account for systematic differences in advertising expenditures (one for consumer goods, zero for producer goods), GROW = percentage change in industry sales between 1967 and 1972, and CAR = average value added per employee of the four largest firms divided by the average added per employee of the fifth through eighth largest firms, a measure of the cost advantage of the four largest firms relative to the next four largest firms (4:3). Allen defined two defense industry data sets by referencing a list of the top twenty industry groups serving the Defense Department published by the U.S. Department of Commerce (28:10). Eleven of these industry groups are in manufacturing (see Table 3) and account for almost two-thirds of total DOD demand. Allen defines four digit census industries from these eleven groups as defense related industries (4:6). 29 defense related industries have complete census data available. The top five manufacturing industry groups alone (aircraft, communications, missiles, ordnance, and shipbuilding) account for more than half of total DOD demand. Allen defines four digit census industries from these five groups as primary defense industries (4:6). These five groups depend on the Defense Department from between 40 to 65 percent of their sales 28:10). Only 9 primary defense industries have complete census data available. The results for these defense industries are compared to a broader group of 307 manufacturing industries (4:5).

Allen's estimated coefficient for C4 is small (about .09) but significant for the total manufacturing sample, a result consistent with a large number of previous industry based structure-performance models (4:6). However, this measure of market power is not significant in the sample of 29 defense related industries (4:6).

Table 3. Top Eleven Manufacturing Groups Serving the Defense Department - 1979

Industry Group	First Demand (millions of $)	Percentage of DOD Total	Percentage of industry Total
[illegible]	11754.2	19.0%	39.6%
Radio & Communications Equipment	10795.9	17.4	51.8
Missiles	4277.0	6.9	58.2
Ordnance	3747.6	6.0	65.0
Shipbuilding & Repair	3424.5	5.5	50.4
Motor Vehicles	1744.5	2.8	1.5
Industrial Organic & Inorganic Chemicals	1269.5	2.0	16.2
Petroleum Refill & Related Products	1106.3	1.8	3.4
Computers & Peripheral Equipment	1046.7	1.7	4.6
Optical & Photographic Equipment	802.7	1.3	5.0
Scientific & Controlling Instruments	736.9	1.2	9.8
11 Group Total	40705.8	65.7	NA
DOD Total	61970.7	104.0	NA

Source: Adapted from Robert W. Degrasse, Jr., "Military Spending and Jobs," *Challenge*, July/August 1983, p 10.

CAR, the large firm efficiency measure, is positively significant for both of these data sets, but the small estimated coefficients (.063 for all manufacturing, .102 for defense related industries) indicates a small economic role for this variable (4:6). The adjusted explanatory power of the complete model $\overline{R}^2$, was .16 for all manufacturing, and .37 for defense related industries (4:13).

Allen proceeds to identify decreasing cost industry subsets for these two data sets as those industries where CAR exceeded 1.15 (4:7). $\overline{R}^2$ values were .28 for total manufacturing, and .58 for defense related industries (4:13), a significant improvement over the broader data base. In these cases, both CAR and C4 remained positively significant, but the C4 estimated coefficient was three to five times as large as the CAR coefficient, identifying concentration as the dominant influence on profits. Large firm efficiency apparently supports significant entry barriers, allowing the leading firms in decreasing cost industries to maintain prices well above what could be obtained through their relative efficiency (4:7).

Turning to Allen's primary defense industries, he found their average concentration was much higher than total manufacturing, their average profitability was higher if measured as return on assets but about the same if measured as price-cost margins, and large firm efficiency was lower than total manufacturing (4;8). CAR and GRO are significant and explain about two-thirds of the profit variability in the primary defense industries (4:9). Concentration is not significant. Sales growth is negative and appears to depress profits. The $\bar{R}^2$ value for the complete model was .45 (4:15). The estimated coefficient for CAR (about 2.4) was about twice as large as for the defense related industries, and about four times as large as for total manufacturing (4:13, 15), indicating large firm efficiency becomes more important as a determinant of profits as the defense industries are more narrowly defined. Since large firm efficiency appears to be relatively low in the defense sector while simultaneously occupying an important role as a determinant of performance, Allen concludes that improvements in this area should reap great benefits for the defense industry.

Allen looks at the relationships among market power, efficiency, and profits at the industry level. Gale and Branch (35:98) assert that an analysis restricted to aggregated industry data may produce a spurious positive relation between concentration and profits. Gale and Branch (35) believe that the true structure-performance relationships lie at the product line or segment level. If true, Allen's study is too aggregated to yield the proper relationships. Allen's method of measuring the relative effects of market power and efficiency seem valid. Unfortunately, his efficiency measure, CAR, has no direct parallel in a firm based study because of data limitations at that level.

As we have seen, the structure, conduct, and performance of the defense sector is unique. In the defense sector, a monopsonist buyer faces a concentrated oligopoly of sellers under highly unusual structural conditions. Because of this or in spite of this, the performance of the defense industries has generally been disappointing, both in terms of profits and prices. The structural reasons for this relatively poor performance may be related to relatively low levels of market power, efficiency, or both. Few studies have explored the structure-performance relationships in the defense sector. It may prove beneficial to understand the nature of those relationships.

IV. Methodology

As stated in the introduction, the purpose of this research is to investigate the relationships between efficiency, market power, and profitability in the defense marketplace. These results will be compared with the relationships observed from another sample of total U.S. manufacturing concerns. The unit of observation will be the firm in both instances. These results will also be compared with previous work, especially firm based studies and/or defense sector studies such as those of Allen and Beverly, Bonello, and Davisson. The years selected for study are the census years of 1972 and 1977, in order to provide for comparisons with previous work.

The Regression Model

The basic structure-performance model that will be used to evaluate these relationships is Allen's model, with some extensions. The basic model is:

$$\text{Profit} = f(C4,\ NCO,\ GROW,\ DISP,\ CDUM,\ KO,\ EFF)$$

where profit is measured either as return on sales (ROS) or return on assets (ROA). Efficiency (EFF) is measured in one of three ways: PROD, CAPEF, COGS. These, and other variables in the model, are defined below.

Return on sales is defined as net income divided by net sales. Both of these items are taken from Standard and Poors' Compustat Data Service. The net income figure is the income or loss reported by a company after expenses, taxes, and losses have been subtracted from all revenues and gains for the period (23:IX-56). Net sales is defined as gross sales less discounts, returns, and allowances (23:IX-71). Return on sales effectively isolates market power, according to Weiss (75:198) because differing capital requirements should not impact returns if capital differences are controlled through a capital-output measure. Also, ROS is the profit measure used by the government in their contractual negotiations with defense firms.

Return on assets is net income divided by total assets. Both these figures come from Standard and Poors' Compustat Data Service. Here total assets represents current assets plus net plant plus other non-current assets, including deferred items, investments and allowances (84:IX-18). Interest payments are excluded from the numerator. The return on assets or return on investment is an important management and investor motivator, and a key factor in the allocation of resources.

C4 is defined as the four firm concentration ratio. This measure was extracted from the U.S. Bureau of the Census, Census of Manufacturers (92, 93), which is gathered once every five years. This paper follows the common practice of identifying this variable as a proxy for market power. The C4 ratio, as opposed to other concentration ratios, was chosen because it is used most often and because it is conveniently published for each four digit manufacturing Standard Industrial Classification (SIC) code by the Census Bureau. The profit measures should be positively related to this market power variable, although the impact is not expected to be very large.

NCO, the number of companies in the industry, should be negatively related to profits since, all other things being equal, the exercise of market power should become more difficult as firm numbers increase. This variable is also extracted from the Census of Manufacturers.

GROW is defined as the percentage change in a firm's net sales between census years, a period of five years. This variable was extracted from the Compustat data. The sign of the growth variable should be positive unless rapid growth causes firms to sacrifice profits to maintain growth or if cost controls break down during periods of rapid growth.

The dispersion ratio, DISP, was initially suggested by Collins and Preston (20) to capture the effects of variation in the geographical scope of markets. The data source is again the Census of Manufacturers. This index of geographical dispersion is calculated as follows: the percentage of each SIC four digit industry's value added accounted for by firms in each of the four Census regions is computed, along with the total manufacturing value added accounted for each Census region. The dispersion ratio, DISP, is the sum of the absolute differences between the percentage of value added (in that particular industry) accounted for by firms in each region and the percentage of total manufacturing value added accounted for by each region. Thus, a value of zero would indicate that an industry is distributed among the four regions exactly as total manufacturing is distributed. A value in excess of one would demonstrate considerable concentration of activity in some area or areas. DISP is expected to be negatively related to profits because national markets imply greater competition and results in lower profits.

CDUM is a dummy variable designed to account for systematic differences in advertising expenditures. It is set to zero for producer goods industries and one for consumer goods industries. The source for this variable was Ornstein's published table of each type of industry by four digit SIC code (73). The expected sign of CDUM is positive, since greater advertising in the consumer goods industries allows firms to differentiate their products in the market, and may serve as an entry barrier to others.

The capital-output ratio (KO) is included as a control variable when the dependent variable is ROS, so that systematic differences in firm capital intensity can be accounted for. It is calculated by dividing gross plant by net sales. Both of these data items are taken from Compustat. Gross plant is defined as all tangible fixed property (generally at cost), such as land, buildings, and equipment which is used in the production of revenue

(23:IX-59). Accumulated reserves for depreciation, depletion, and amortization are included because subtracting these items to get net plant introduces more noise from differing accounting practices. The expected sign of this variable is positive, since greater capital intensity requires higher ROS to yield a given investment return.

The first efficiency variable, PROD, was suggested by Caves, et al (17), as the most straightforward measure of labor productivity. The PROD variable in this paper is defined as (net sales minus raw materials), divided by the number of employees for each firm. Both variables are taken from Compustat. Net sales minus raw materials represents value added, the difference between the value of products produced and the value of the input materials used in production. Thus, PROD measures how much the average worker contributes to value created by the firm.

A second efficiency variable, CAPEF, is defined as gross plant divided by the number of employees. Once again, these variables are from Compustat. This variable measures the capital-labor ratio, which describes how much capital the average worker has available. The more capital available per worker, the more efficient that worker should be. Thus, CAPEF attempts to capture that fraction of any efficiency difference between firms caused by greater capital per worker.

The final efficiency variable, COGS, was suggested in the Bonello study (8:29), as a possible efficiency measure.

Its efficacy as an efficiency variable, however, is subject to some question because the impact of factor prices, particularly labor, is unknown. This problem will be discussed more fully in the analysis section. COGS is defined as the cost of goods sold divided by net sales. Compustat defines COGS as all costs directly allocated by the company to production, such as labor, materials, and overhead (23: IX-27). Cost of goods sold includes items such as salaries, transportation, warehouse expense, and utilities, but excludes gross plant, depreciation allocated to cost of goods sold, idle plant expense, and moving expense (23:IX-28). COGS attempts to capture how well costs are managed for these factors of production, which exclude capital expense. All three of the efficiency variables should be positively related to profits. The efficiency variables are subject to two potential limitations, which will be discussed after the extended model is defined.

This basic model is extended by the addition of two other predictor variables. The first variable, SIZE, is a measure of relative firm size. The larger firms, suggest Hall and Weiss (42:219), enjoy higher profits because they can make large scale investments the smaller firm cannot afford. Many of these large scale investments will yield disproportionately high returns (42:319). Hall and Weiss describe this "availability of capital" entry barrier as a potentially significant structural element that turns out to be distinct from C4 as a determinant of profits

(42:319, 326). Following Hall and Weiss, this SIZE variable is defined as the reciprocal of the base ten logarithm of a firm's year-end total assets, expressed in thousands of dollars. Thus,

$$SIZE = \frac{1}{Log(Assets)}$$

where assets is derived from the Compustat data and includes all current and non-current assets plus net plant (23:IX-18). A SIZE definition expressed in terms of assets is superior to an employment or sales based variable because it is the difficulty of financing large sums of assets that limits entry into certain areas (42:322). Hall and Weiss used a logarithmic form because they reasoned that the profit advantages of additional units of size become less pronounced as firm size gets larger and larger (42:322). They used the reciprocal form because they felt another percentage addition to assets would in fact be easier for the larger firm (42:322). In other words, a $100 million firm might have greater difficulty entering an industry with a $50 million capital requirement than a billion dollar firm would have entering an industry with a $500 million capital requirement (42:322). This form was also chosen, in part, to correct for heteroskedasticity in the raw measure. The expected sign of SIZE is negative because it is in the reciprocal form. Firm size should be positively related to profits.

The second additional predictor variable added to the model is RD, defined as firm research and development (R&D) expense divided by the firm's net sales. Both items are derived from Compustat. R&D expense specifically excludes customer or government sponsored R&D, but does represent all annual costs associated with the development of new products or services (23:IX-66). The expected sign of this variable is positive, because of possible scale economies in the R&D process, the accumulation of patents of technical knowledge, cost reductions, and product differentiation. RD should be even more important to firms in the defense sector because the ability to win contracts is highly dependent on proven R&D capability.

As mentioned earlier, the efficiency variables are subject to two potential limitations. First, productivity differences between firms may be offset by higher wages for the more productive workers, resulting in a zero, or perhaps negative net effect on profits. This potential limitation would affect PROD and COGS. Following Allen (3:4-5), this problem can be investigated by regressing wages onto the efficiency variable to see how much productivity impacts wages. Unfortunately, the Compustat data base had far too many missing values for the wages variable to allow investigation of this potential limitation. Allen found a positively significant relationship between wages and CAR, his efficiency variable, but the impact of a change in CAR on wage rates was fairly small, allowing the firm to enjoy lower costs when productivity improves (3:4). Allen's study was industry based, so there is some question as to the extent one can transfer his results to firm based data. Given the Compustat data limitations we shall assume that productivity differences between firms are not offset by higher wages and let the model results tell us otherwise.

Another potential limitation may be that the efficiency variables are in fact measuring market power to some degree. The selling price which the efficiency measure is linked to may be inflated through the presence of market power. Lower costs may also be captured by economies of scale embodied in the SIZE variable. The SIZE variable was earlier described as an entry barrier, but here we are investigating its impact as a possible efficiency variable. Economies of scale can be viewed both as an entry barrier and a measure of technical efficiency. To see how market power or SIZE affects the efficiency measures, we can regress the latter on the former, using total manufacturing data. The simple correlations for PROD are:

	PROD	SIZE	C4
PROD	1.0	-.19	.10
SIZE		1.0	-.12
C4			1.0

The correlations are fairly low, indicating a lack of similarity between these variables (one must remember, the SIZE variable is a reciprocal measure, so the sign is reversed). Market (C4) and average size only explain about 2.5 percent of the variability in PROD, as shown by the regression equation:

$$PROD = 55.1 - 117.1\ (SIZE) + .08\ (C4) \qquad \bar{R}^2 = .025$$
$$(4.62) \quad (2.02) \qquad\qquad (.881) \qquad (\ ) = t\ VALUE$$

The SIZE variable is significant at the .05 level, which suggests it does predict PROD values fairly well. Economies of scale play a role in PROD, but the $\bar{R}^2$ value indicates the role is a small one. A great deal of information is contained in the constant term, judging by its size and significance.

The use of COGS presents a similar picture. The simple correlations and regression equation for COGS are:

	COGS	SIZE	C4
COGS	1.0	.10	-.033
SIZE		1.0	-.12
C4			1.0

$$COGS = .55 + .50\ (SIZE) + .00007\ (C4) \qquad \bar{R}^2 = 0$$
$$(1.19) \qquad\qquad (.110) \qquad (\ ) = t\ VALUE$$

In this case, neither variable is significant and the $\bar{R}^2$ value is zero, so it seems clear COGS is not contaminated by market power or size considerations. Finally, here are the simple correlations and regression equation for CAPEF:

	CAPEF	SIZE	C4
CAPEF	1.0	-.31	.06
SIZE		1.0	-.12
C4			1.0

$$CAPEF = 43.7 - \underset{(3.62)}{138.5\,(SIZE)} + \underset{(.237)}{.014\,(C4)} \qquad \bar{R}^2 = .082$$

( ) = t VALUE

SIZE is significant at the .01 level, which is not surprising, since both SIZE and CAPEF contain a measure of assets or capital. More importantly, market power (C4) once again shows no relationship with the efficiency measure. The $\bar{R}^2$ of .082 is still quite low, and mostly accounted for by the SIZE variable. The corresponding correlations and $\bar{R}^2$ values are slightly higher for the defense data, but lower costs through efficiency still remain the dominant influence, relatively uncontaminated from market power.

The Compustat Data Base

All firm data for this study comes from Standard and Poors' Compustat Services, Inc., a computer tape consisting of balance sheet and income statement items for all the consolidated corporations listed on the New York and American stock exchanges, plus the 850 companies from the Over-the-Counter stock exchange that command the greatest investor interest (23:II-2). The data base consists of a total of 2459 firms. Each firm is assigned an array of 175 data items for every year from 1960 to 1979. A firm must possess $16 million in net tangible assets to be listed on the New York stock exchange, but only $4 million in net tangible assets for the American exchange. The only requirement to be traded Over-the-Counter is that the firm must meet state and Securities and Exchange Commission (SEC) requirements (23:II-4).

Compustat Services, Inc., is rigorous in its data collections and verification. They continually access a number of primary sources for their data. Information is compiled from SEC forms 10-K, public reports filled with corporate information that must be filed with the SEC; annual and quarterly shareholder reports; information compiled by Interactive Data Services, Inc., which provides price, dividend, shares-traded and other data; the National Association of Securities Dealers automated quotations, for Over-the-Counter data; and a variety of other sources and contacts (23:II-5). This information is given to statistical accountants who interpret the source documents and enter the data according to a balance sheet and income statement format with standardized definitions written in conjunction with the Financial Accounting Standards Board, the American Institute of Certified Public Accountants, and with leading accounting firms (8:10). Compustat Services validates their data in two ways. First, a spot check of certain data items is conducted with original source documents. The second validity check involves computer generated reports and tests that highlight data items with values beyond their expected ranges. The identified data items are then reviewed for accuracy (8:11).

Each firm is assigned a unique company number and an industry classification number. The Compustat industry classification numbers are assigned by analyzing the product line breakdown in each SEC form 10-K (23:8B-4). Additional sources such as stock reports or annual reports are used when necessary. The product line accounting for the largest percentage of sales determines the industry classification code (23:8B-4). The industry classification codes conform as nearly as possible to the SIC codes, but Compustat Services has assigned three and even two digit codes to the more diversified firms involved in more than one aspect of an industry (23:8B-4). Thus, Dow Chemical is assigned a broad two-digit SIC code of 2800, Chemicals and Allied Products, instead of a more specific four digit SIC code of, for example, 2812, Alkalies and Chlorine. Some industry classifications with only a small number of companies have also been collapsed into two or three digit SIC codes so that SIC groupings could be consolidated. These practices created special problems in this study's data bases.

The first problem is related to diversification, and is actually common to all firm based studies. It is inappropriate to apply or match up industry based measures of market power or other factors with firm based data from highly diversified firms because those industry based characteristics would apply only to a relatively small segment of the firm. This is a major reason why firm based studies are becoming less common (See Table 1). Industry based variables such as concentration ratios, the number of firms in the industry, dispersion ratios, and industry growth measures are compiled by the U.S. Bureau of the Census on the basis of individual four digit SIC codes. A firm may have 40 percent of its business in one four digit market, another 30 percent in a second four digit market, and the remaining 30 percent in a third four digit market. Since the firm is probably classified by the first SIC code, the researcher without access to segment, or product line division based data will not know that he/she is applying industry based data to the whole firm when less than half the firm is in fact part of that industry.

Another way of describing this diversification problem would be as a heterogeneity problem between firm based variables on the one hand and industry based variables on the other. Of course, if every firm restricted itself to only one four digit SIC industry, there would be no real heterogeneity problem. This problem has been dealt with in a number of different ways for firm based studies. Hall and Weiss (42:320) and Shepherd (87:28), for example, simply exclude firms which they feel are too diversified.

The Bonello study defines all variables on a firm basis, but this means they have no measure of market power, among other things, in their models, which is a crucial shortcoming of their paper. Gale (34:420) obtains an estimate of how diversified firms are distributed across four digit industries by accessing Dun and Bradstreet's computer data file, which contains a distribution of the firm's employees and profits across four digit SIC industries. This information allows Gale to construct a market share variable, which has been shown to be a more powerful performance indicator than the more commonly used concentration indices (34, 35, 79, 86, 87). The diversification, or heterogeneity, problem has prevented most researchers from attempting to construct a market share variable unless they had segment based data available to them in some form. Even Shepherd, one of the first authors to actually build a viable market share variable, did so by approximating segment or product line data through "a large variety of official, company, industry, and financial sources" (87:28).

Part of the diversification problem for this study has already been taken care of because the more diversified firms tend to be listed at the two digit level or in a special Compustat industry code of 9997, which is for conglomerates that do not fit well in any SIC category. These areas are excluded from the data set for this study. To see how diversified the remaining firms were in this study's data bases (their construction will be explained shortly), a second Compustat data tape organized by business segment was accessed and the relevant defense and total manufacturing firms were extracted to see how many segments existed on average in the 1977-1980 time frame, which is when this segment data first became available. Defense firms averaged 1.6 segments with a standard deviation of 1.0; total manufacturing firms averaged 1.3 segments with a standard deviation of .9. That is, our firms typically have less than two major product lines, which would indicate that firms are typically aligned with SIC industries wherein they have at least 51% of their sales.

Another problem specific to the Compustat tape is their practice of assigning two or three digit SIC codes to diversified firms. One problem is again how to match firm and industry based variables. The researcher can compute weighted averages for industry based variables by weighting each four digit value within the more aggregated two or three digit grouping by the share of total sales that four digit industry produces, but of course this introduces noise to the data. In addition, since the three digit market is less well defined, the validity of looking at relationships on this level is somewhat less justified. A researcher using this data must choose whether or not to include the three digit level firms. This study initially uses both types of data sets.

Data Sample Characteristics

The total manufacturing data bases for this study started with a random sample of 300 1972 and 300 1977 U.S. manufacturing firms with three or four digit SIC codes from the Compustat data tape, excluding firms from industries designated "not elsewhere classified", a catchall code which does not correspond well to true markets. For the more aggregated three digit level firms, in this and all other data based including three digit firms, C4 was calculated by weighting the Census of Manufacturers' (92, 93) four digit C4 values within the three digit market by the value of shipments associated with those four digit markets. NCO, GRO, and DISP were all calculated as before, except now on the three digit level for three digit firms. An aggregation indicator, AGG, was added as a dummy variable to see what sort of difference Compustat's aggregation practice had on the models. Two more total manufacturing data bases were also built by eliminating all the three digit firms, resulting in 132 firms for the 1972 data and 129 firms for the 1977 data. For these and all other data bases, all firm based variables are averaged three year values about the year of interest, either 1972 or 1977. 1972 values average 1971, 1972, and 1973 figures, while 1977 values average 1976, 1977, and 1978 figures. This was done to reduce random fluctuations and stabilize the data. Both the basic and extended (including RD and SIZE) models were run against these data bases, using (as throughout the study) stepwise regression and ordinary least squares.

Defining the defense sector was more difficult. One of the ways it was defined was through the same process Allen (4) used to define his defense related and primary defense industry data sets. Using this procedure, the defense related data base consists of 212 1972 firms and 237 1977 firms from 40 three and four digit industries identified from Degrasse's (28:10) eleven top manufacturing industries serving the Defense Department. All firms with complete data from these industries were included. Four digit defense related data bases were also built by eliminating all three digit level firms. Complete data was available for 172 1972 firms and 190 1977 firms. As throughout the study, both the basic and extended models were applied to these four data sets. DISP was excluded from all defense regressions because of the national character of defense markets. CDUM was also excluded because all defense firms are making producer goods.

Defense related firms were also established for each year by referencing DOD's 100 Largest Defense Contractors and Their Subsidiary Corporations for 1972 and 1977 (30) and extracting all of these firms from the Compustat tape that have complete data and are recorded at the three or four digit level. The top 100 contractors are based on the total value of annual government contracts to the firm. This procedure resulted in 38 firms for 1972 and

42 firms for 1977. This data set turned out to be a subset of the defense related data set. Firms from all eleven top manufacturing industries that serve the DOD were represented. Since about half of these firms were at the three digit level, further reduction to include only four digit industries was deemed unwise because of sample size limitations. These 1972 and 1977 defense data sets include a new predictor variable, DEF, which is the percentage of the firm's sales that go to the government. DEF is defined as total government contracts (derived from DOD's top 100 compilation) divided by net sales (from Compustat).

To summarize to this point, 10 data bases have been constructed: 4 for total manufacturing, 3 and 4 digit and 4 digit only for 1972 and 1977; 4 for defense related firms, 3 and 4 digit and 4 digit only for 1972 and 1977; and 2 for defense related industries from the top 100 contractors, 3 and 4 digit, for 1972 and 1977. Both the basic and extended models were run against these data bases, both with ROA and ROS, and with either PROD, CAPEF, COGS, or no efficiency variable. This resulted in 10 data bases x 2 models x 2 dependent variables x 4 efficiency possibilities = 160 regression runs. The results will be more fully discussed in the next chapter, but basically, all the 1977 data was very noisy, resulting in very few significant relationships and non-intuitive signs. The 1972 data was much better behaved, yielding the expected relationships and showing significance.

Also, the AGG variable lended virtually no information to these models, indicating that the three and four digit data and the four digit only data held no significant contradictory information.

For these reasons, the study then focused on 1972 and four digit data, leaving a 1972 total manufacturing four digit subset, a 1972 defense related four digit subset, and a defense related "top 100" 3 and 4 digit 1972 primary defense subset. In an attempt to further define the defense sector, an alternative primary defense sample was constructed following Allen (4). All 3 or 4 digit firms from industries in the top 5 defense manufacturing groups identified by Degrasse (23:10) were extracted from Compustat. 55 of these firms contained complete data. All firm based variables were introduced alone first against both ROS and ROA. These included GROW, DISP, and CDUM (for total manufacturing), KO (when ROS is used), the EFF variables, PROD, CAPEF, or COGS, SIZE, and RD. This was done to see if $\bar{R}^2$ values would increase significantly when only firm based variables were in the model. Then C4 was added for each EFF variable to see what effect it would have without the other industry based variables, NCO and DISP, particularly NCO, which was generally correlated about .4 with C4. Lastly, the full model was run for the 3 EFF variables. This resulted in 3 data sets x 3 model variations x 2 dependent variables x 3 efficiency variables = 54 regressions.

Since the correlations between C4, PROD, COGS, CAPEF, and SIZE for the primary defense group are fairly high. each efficiency measure is regressed on C4 and SIZE to see if the efficiency variables may be reflecting market power or economies of scale. This is the same test run earlier for manufacturing firms. The simple correlations and regressions for PROD follow:

	PROD	SIZE	C4
PROD	1.0	-.20	.26
SIZE		1.0	-.54
C4			1.0

$$\text{PROD} = 30.26 - \underset{(.533)}{20.03}\,(\text{SIZE}) + \underset{(1.322)}{.088}\,(\text{C4}) \qquad \bar{R}^2 = .035 \qquad (\;) = t \text{ value}$$

Neither variable is significant and the PROD correlations are fairly low. The total amount of variability explained by SIZE and C4 is only about 3.5 percent, so PROD seems relatively clear of market power of scale economy effects.

The simple correlations and regressions for COGS are:

	COGS	SIZE	C4
COGS	1.0	-.10	.55
SIZE		1.0	-.54
C4			1.0

$$\text{COGS} = .88 - \underset{(2.14)}{.89}\,(\text{SIZE}) + \underset{(2.97)}{.0022}\,(\text{C4}) \qquad \bar{R}^2 = .330 \qquad (\;) = t \text{ value}$$

In this case both C4 and SIZE are significant. The COGS variable probably shows increased costs when C4 increases because wages tend to increase where monopoly power is present. Both economies of scale and market power play some role in COGS, but the $\bar{R}^2$ value still indicates a relatively small role for each.

The simple correlations and regressions for CAPEF are:

	CAPEF	SIZE	CY
CAPEF	1.0	-.32	.40
SIZE		1.0	-.54
C4			1.0

$$CAPEF = 10.68 - \underset{(2.147)}{20.346}\,(SIZE) + \underset{(.951)}{.082}\,(C4) \qquad \bar{R}^2 = .141$$

( ) = t VALUE

SIZE is significant at the .05 level because both SIZE and CAPEF contain a measure of capital. The relationship between C4 and CAPEF is not significant, however. The $\bar{R}^2$ value indicates that only a fairly small amount of the variation in CAPEF is captured by SIZE or C4, so this measure is relatively free of these influences also.

To check for possible heteroskedasticity effects, the elongated model was run against each of these three data sets and the estimated $\hat{Y}$ values were plotted against the residuals to check for any pattern. No pattern in the plots was detected, indicating that nonconstant error term variance was not a significant problem. The correlation matrices (See Tables 4, 5, 6, and 7) show little multicollinearity. There was also no real problem with outliers, and none were eliminated or modified. The basic regression results and their analysis are presented in Chapter IV.

Table 4

Correlation Matrix of 132 Manufacturing Firms, 1972

	ROA	ROS	C4	NCO	GRO	DISP	CDUM	KO	RD	SIZE	COGS	PROD	CAPEF
ROA	1.00	.91	.15	-.01	.09	-.10	-.00	-	.14	.01	-.40	.10	-.10
ROS		1.00	.10	.08	.17	-.03	-.02	.10	.20	-.11	-.48	.10	.02
C4			1.00	-.26	.07	.29	.37	-.05	.11	-.12	-.00	.10	.06
NCO				1.00	-.02	-.00	.12	.06	-.07	-.04	-.05	-.14	-.08
GRO					1.00	.01	-.11	-.02	.12	-.25	-.05	.13	.10
DISP						1.00	.20	-.15	.07	-.07	-.10	-.17	-.21
CDUM							1.00	.01	-.26	-.27	-.10	.33	.24
KO								1.00	-.14	-.31	.11	-.04	.71
RD									1.00	.08	-.36	-.12	-.14
SIZE										1.00	.10	-.19	-.31
COGS											1.00	.17	.15
PROD												1.00	.55
CAPEF													1.00

Table 5

Correlation Matrix of 172 Defense Related Manufacturing Firms, 1972

	ROA	ROS	C4	NCO	GRO	KO	RD	SIZE	PROD	COGS	CAPEF
ROA	1.00	.87	-.02	-.04	-.01	--	-.00	-.08	114	-.26	.05
ROS		1.00	-.10	-.16	.09	.22	-.02	-.17	.26	-.33	.32
C4			1.00	.00	-.07	-.10	-.05	-.20	-.21	.13	-.20
NCO				1.00	-.07	-.36	-.07	.30	-.44	.11	-.41
GRO					1.00	.35	-.11	-.02	.16	-.10	.33
KO						1.00	-.14	-.35	.49	-.28	.84
RD							1.00	.04	-.29	-.46	-.25
SIZE								1.00	-.40	-.05	-.39
PROD									1.00	.05	.84
COGS										1.00	-.11
CAPEF											1.00

Table 6

Correlation Matrix of 55 Primary Defense Manufacturing Firms, 1972

	ROA	ROS	C4	NCO	GRO	KO	RD	SIZE	PROD	COGS	CAPEF
ROA	1.00	.96	.03	.00	.07	--	.04	.13	.22	-.43	-.12
ROS		1.00	.00	.02	-.00	-.05	.08	.15	.13	-.48	-.03
C4			1.00	-.78	-.24	.23	-.15	-.54	.26	.55	.40
NCO				1.00	.30	-.25	-.00	.32	-.22	-.33	-.40
GRO					1.00	-.26	-.20	.03	.31	-.27	-.17
KO						1.00	.02	-.10	-.29	.18	.85
RD							1.00	-.02	-.25	.02	-.09
SIZE								1.00	-.20	-.10	-.32
PROD									1.00	.19	.17
COGS										1.00	.31
CAPEF											1.00

Table 7

Correlation Matrix of 38 Defense Related Firms
From the Top 100 Defense Firm Listing, 1972

	ROA	ROS	C4	NCO	GRO	KO	RD	SIZE	DEF	PROD	COGS	CAPEF
ROA	1.00	.94	.13	-.16	.37	--	.23	-.51	-.67	.31	-.57	.34
ROS		1.00	-.03	-.20	.30	.73	.28	-.59	-.46	.38	-.72	.49
C4			1.00	-.38	.12	-.23	-.03	-.25	-.06	-.27	.17	-.34
NCO				1.00	.14	-.38	.29	.49	.05	-.33	-.03	-.32
GRO					1.00	.13	.14	-.37	-.70	.03	-.32	.04
KO						1.00	.09	-.56	-.46	.54	-.61	.72
RD							1.00	-.10	-.15	-.39	-.56	-.30
SIZE								1.00	.60	-.30	.36	-.38
DEF									1.00	-.28	.53	-.34
PROD										1.00	.19	.63
COGS											1.00	-.03
CAPEF												1.00

V. Analysis

This analysis of the regression results will focus on the relative economic and statistical significance of the various model elements, the difference between these relationships among total manufacturing, defense related, and primary defense firms, and how well these results agree with previous works by other authors. In particular, we will be looking for the relative roles of efficiency and market power in the determination of profits.

Data Comparisons

The four data sets of interest are the four digit 1972 total manufacturing firms, the four digit 1972 defense related firms, the three and four digit 1972 primary defense firms, and the three and four digit defense related firms extracted from DOD's list of the top 100 defense contractors for 1972. The first comparisons between data groups may be made by looking at the mean values for the various structural elements. Mean values of profit measures and structural variables for the four groups are listed in Table 8. The defense sector firms differ from all manufacturing firms in a number of ways. First of all, the defense sector is considerably more concentrated than all manufacturing. Total manufacturing has an average C4 of 36.7, defense related firms have an average C4 of 42.3 to 52.9 and primary defense firms

Table 8

Mean Values of Selected Variables for Defense and Non Defense Manufacturing Firms, 1972

Firm Type	ROA	ROS	C4	GRO	KO	PROD*	COGS	CAPEF*
132 Manufacturing Firms	6.22 (5.03)	4.72 (4.08)	36.7 (17.6)	68.7 (88.0)	.42 (.24)	33.4 (18.6)	.662 (.132)	14.8 (12.7)
172 Defense Related Manufacturing Firms	4.72 (4.08)	4.00 (5.05)	42.3 (17.7)	98.0 (226.9)	.58 (.50)	48.2 (43.4)	.697 (.129)	39.8 (68.1)
38 Defense Related Manufacturing Firms Among the Top 100 Defense Firms	5.10 (3.91)	4.51 (3.93)	52.9 (21.9)	25.6 (29.8)	.58 (.38)	49.0 (54.9)	.738 (.177)	38.8 (67.7)
55 Primary Defense Manufacturing Firms	4.18 (5.49)	2.96 (3.95)	52.9 (21.9)	66.7 (139.5)	.33 (.16)	29.2 (8.0)	.768 (.106)	9.3 (4.8)

( ) indicates standard deviation

* set values are percent except PROD and CAPEF which are measured in thousands of dollars per worker

average 52.9. This result is well known, and agrees with those reported by Gansler (36:43) and Allen (4:8), among others. Firm sales growth for the period 1967-1972 was 68.7 percent for all manufacturing, 25.6 to 98.0 percent for defense related firms and 66.7 percent for the primary defense firms. This does not compare well with Allen's measure of industry growth for the same period in the defense sector, since he shows a negative growth value for his primary defense industries (4:14). The probable reason for this difference is that my firm based primary defense data set includes some percentage of sales outside the defense industries because of diversification, while Allen's industry based primary defense data set includes only sales in those industries. For example, Thiokol, a firm in the missile production industry, made only 43 percent of its sales to the government in 1972 (30). The relationships among the capital-output ratios indicate more capital per unit of output in the defense related firms, including the "top 100" primary defense firms, as compared with all manufacturing, but less capital per unit of output in the primary defense firms, a result in concert with Allen (4:14). Apparently capital investment is relatively low in the primary defense firms. These firms are from the aircraft, communications, guided missiles, ordnance, and shipbuilding industry groups. Defense related firms and "top 100" defense firms also include firms from the motor vehicles, industrial chemicals, petroleum refining, computers, optical and photographic equipment, and scientific and control instruments industry groups. Capital investment in the primary defense firms is especially low when compared to defense related firms and "top 100" defense firms. This is not surprising because the above mentioned industry groups are highly capital intensive, and technologically oriented, much more so than the industry groups that make up the primary defense firms. The capital-output measure for the primary defense firms is understated, however, because capital supplied by the government is not included in the defense data. This makes comparisons of capital intensity among groups more difficult.

Both measures of profits show lower returns in the defense sector. The ROS figures agree with the trend illuminated by the large Profit '76 study. The Profit '76 study found average 1975 ROS values of 6.7 for manufacturing and 4.7 for all defense contractors. The present study found 1972 ROS values of 4.7 for manufacturing, 4.5 for "top 100" defense related firms, 4.0 for defense related firms, and 3.0 for primary defense firms. As Gansler notes, most studies agree that ROS is generally lower for defense firms, but considerable disagreement about relative profit performance exists when ROA is used as a profit measure (36:86). The present study found the same pattern as with ROS: ROA values of 6.2 for manufacturing, 5.1 for "top 100" defense firms, 4.7 for defense related firms, and 4.2 for primary defense firms. The Profit '76 study found average 1975 ROA values of 10.7 for manufacturing and 13.5 for all defense contractors (31:IX-14). Some other studies have shown high defense ROS profits, (31), lower defense ROA profits (36:87), or no difference between total manufacturing and defense profits (8, 9). The different results can be accounted for by the different ways the defense sector and/or the return on assets measure were defined. Defense definitions that include firms or industries from the motor vehicles, industrial chemicals, petroleum refining, computers, optical and photographic equipment, and scientific and control instruments industry groups will tend to show higher profit margins, in part because of their higher capital intensity. There is also some variation in how ROA is defined. The "assets" in return on assets in this study, for example, does not correspond to the "capital" in the capital-output ratio.

The assets value in this study represents net plant plus current assets plus non-current assets, including intangible assets, deferred items, and investments and advances (23:IX-18). "Capital" is defined in this study as gross plant, which is all tangible fixed property (generally at cost) used in the production of revenue (23:IX-59). If "capital" and "assets" were identical,

$$\frac{\pi}{K} = \frac{\pi}{S} \cdot \frac{S}{K}$$

where π = returns, K = capital, and S = sales. Or, stated differently,

$$ROA = ROS/KO$$

This equality does not hold true in this study because my definition of assets does not correspond to my definition of capital. My assets value is generally much larger, which accounts for the much lower ROA figures in my study, compared to most studies, including the Profit '76 report (31: IX-12). My implied sales-capital ratios (1/K) are very close to those reported by Gansler (36) and Allen (4), so the discrepancy is centered on my assets definition. If ROA is calculated by dividing my ROS by my KO, the resulting ROA values are 11.51 percent for manufacturing, 6.90 and 7.78 percent for defense related firms, and 8.99 percent for primary defense firms. These values are much closer to the values reported by Profit '76 and other studies, however the profits of defense firms remains low relative to all manufacturing.

Turning to efficiency ratios, Table 8 shows that both PROD and CAPEF are at their lowest in the primary defense firms. The average primary defense worker contributes $29.2 thousand in value added and has available to him/her only $9.3 thousand in capital equipment, while the counterpart in all manufacturing contributes $33.4 thousand in value added and may work with an average of $14.8 thousand in capital equipment. But, the defense related firms, including those among the "top 100" defense firms, appear to be the most efficient, with the average worker contributing $48.2 thousand in value added and working with $39.8 thousand in capital. The workers from the motor vehicles, industrial chemicals, petroleum refining, computers, optical and photographic equipment, and scientific and control instruments industry groups appear to be more productive and have more capital available to them. Apparently, the top 5 defense industry groupings, which consumed a total of 45 percent of the DOD budget in 1979 (28:10), are dominated by firms that are lacking in capital investment and less productive in terms of labor. The CAPEF measure does not include government owned capital as part of the gross plant numerator. For this reason, the CAPEF variable is underestimated, particularly for primary defense firms, which makes comparisons more difficult. This should be kept in mind when reviewing these figures.

Manufacturing firms in general hold the line on costs more effectively with a COGS value of .662, as opposed to .697 to .738 for defense related firms, and .768 for primary defense firms. Apparently, firms doing business with the Department of Defense are not as successful at keeping their costs down as are firms unrelated to DOD. COGS is a combination of factor price differences and factor productivity differences. It may be that wage differences account for most of the variation in COGS. Labor costs typically make up 60 to 70 percent of a firm's total costs, so it would account for an even greater percentage of the costs captured by COGS. Labor costs were not available as part of the Compustat data, so the extent to which wages drive the variation in COGS was not determined. COGS may very well be essentially reflecting factor prices, particularly labor costs, not factor productivity.

Keeping in mind the limitations inherent in the three efficiency variables, defense related firms appear to be about as efficient as all manufacturing. This, of course, reflects the role of industry groups such as computers, industrial chemicals, and scientific and control instruments, which all showed very high efficiency levels. These industry groups are characterized by efficient, high technology operations to such an extent that the lower efficiency values from the primary defense industry groups (aircraft, shipbuilding, ordnance, etc.) are more than offset. Primary defense firms are least efficient for all three measures. The poor price performance of the defense sector no doubt reflects, at least in part, the low productivity of the primary defense firms.

The Beverly study (8) lists averages for all their variables industry by industry. Since they do not say how many firms are represented in each industry, comparisons with my results are difficult. The Beverly paper found higher ROS values in defense firms in 16 out of 33 industries, and higher ROA values in 17 of 33 industries

(8:48-51), leading them to conclude that no consistent or significant differences existed between defense and control firms. Their average values for efficiency and other variables are discussed in Chapter 3. They found that labor productivity was lower for defense firms in most industries, COGS was higher, the capital/employment ratio was lower, and the capital-output ratio was lower. These results essentially agree with the averages listed in Table 8.

Allen (4) uses different profit measures in his study. He found that price-cost margins were highest for defense related industries and lowest for primary defense industries, with manufacturing again falling in between these values. Also, the magnitude of Allen's profit differentials is about twice mine, in terms of percentages. These results do not agree with mine, probably because of differences in data caused by his industry based approach compared to my firm based approach. The trend between Allen's CAR variable and my PROD variable is the same, although Allen's values are more closely bunched. For both studies, defense related firms enjoyed the highest labor productivity, followed by manufacturing, with primary defense firms the least productive.

Correlations Between Structural Variables

Simple correlations between the structural variables and profit measures for the four data sets are shown in

Tables 4, 5, 6, and 7. Collinearity among the variables is generally low so that it should not be a problem when interpreting the results. There are some correlations that bear comment, however. PROD and CAPEF apparently work well as alternative measures of labor productivity, except for the primary defense group. The correlations range from .55 to .84 in the data sets excluding primary defense. These high correlations indicate that PROD and CAPEF are measuring essentially the same thing. Their correlation in the primary defense firms drops to .17, probably because the failure to account for government supplied capital impacts most heavily in this group. The consistently low, usually positive, correlations between COGS and either PROD or CAPEF tend to support the view discussed eariler that COGS essentially reflects labor costs and not productivity or efficiency.

Market power (C4) is only slightly correlated with the three efficiency variables in manufacturing, indicating that market power is not contaminating these efficiency measures. The situation is not so benign in the defense sector, however. All defense data sets show that C4 is positively correlated with COGS. This indicates that higher C4 values imply higher costs. In the primary defense firms, PROD is also positively correlated with C4, indicating that labor productivity rises with concentration. This may mean that C4 is contaminating PROD. Or, increases in SIZE may be implying both higher C4 and greater productivity is offset by higher wages captured by COGS. In both the defense related and "top 100" defense firm data sets, PROD is negatively correlated with C4. One would expect a positive relationship. C4 should raise profits which raises value added, increasing labor productivity. The probable reason for the negative correlation is that, at least for these two data sets, C4 is usually negatively correlated with profits. Later we will see that these negative correlations are not significant.

KO and CAPEF are highly correlated, which affects the regression runs with ROS when both are present. RD is negatively correlated with COGS in the manufacturing, defense related, and "top 100" models, indicating that R&D efforts do hold down costs, but RD's correlation with COGS is near zero in the primary defense firms, indicating no relationship. Of course, R&D expenditures would not lower costs or increase profits in the same time period. The assumption here is that R&D expenditures stay relatively constant for a long enough period of time so that the benefits can be linked to the policy. KO is highly correlated with ROS in the "top 100" defense firms. This relationship is not nearly as strong in the other samples. Apparently, the amount of capital available in these leading primary defense firms is a strong determinant of profits.

Regression Results

Regression results for the four digit sample of all manufacturing firms are presented in Table 9. The $\overline{R}^2$ values when COGS is used as an efficiency variable compare favorably with previous work (4, 50, 51, 78), but when PROD or CAPEF is used the $\overline{R}^2$ values are quite low. This no doubt reflects the heterogeneous nature of the consolidated firm data. The signs of most of the variables are as expected with three exceptions. The positive sign on the NCO variable may reflect an umbrella effect from market power (C4). Other authors have reported a similar result (3, 50). The negative sign on the CDUM variable is difficult to explain. This result is contrary to all previous study results and probably reflects inadequacies in the data. RD is negative when COGS is entered as an efficiency variable and may reflect collinearity between these two variables. The signs of all other variables correspond well with established work (4, 34, 42, 85).

Equations 1g and 1h offer a fairly direct comparison between Allen's (3) industry based model and my firm based basic model (not including RD and SIZE). Allen uses CAR as opposed to PROD, and price-cost margins in place of ROS. Except for these differences, the models are basically the same. The signs of two variables differ between the models. GRO is positive in my model but negative in Allen's model, and CDUM is negative in my model but positive in Allen's model. As noted above, the negative sign

Table 9

Regression Analysis for 132 Manufacturing Firms, 1972

	ROA	C4	NCO	GRO	DISP	CDUM	KO	RD	SIZE	CAPEF	R^2	$\bar{R}^2$
1a		.080	.0002	.003	-3.29	-1.16	NA	-.174	-12.12	-17.70	.242	.193
		(2.844)[a]	(.5789)	(.7126)	(2.377)[b]	(1.166)		(.8996)	(.7845)	(5.283)[a]		
1b		.060	.0003	.003	-2.44	-.412	NA	.257	-5.82	.024	.075	.023
		(1.974)[b]	(.7211)	(.0731)	(1.546)	(.3547)		(1.325)	(.3419)	(.8847)		
1c		.058	.0001	.004	-3.52	.355	NA	.236	-.230	.064	.090	.031
		(1.916)[b]	(.3130)	(.8427)	(2.234)[a]	(.3247)		(1.223)	(.1320)	(1.647)		
	ROS											
1d		.048	.0004	.005	-1.597	-1.277	1.171	-.076	-8.61	-15.40	.296	.244
		(2.226)[b]	(1.524)	(1.264)	(1.455)	(1.628)	(.8841)	(.4979)	(.6972)	(5.838)[a]		
1e		.030	.0004	.005	-1.171	-.381	1.764	.292	-15.72	.005	.100	.033
		(1.321)	(1.396)	(1.118)	(.9102)	(.4084)	(1.176)	(1.861)[c]	(1.128)	(.2812)		
1f		.031	.0005	.004	-.848	-.708	3.781	.287	-12.87	.057	.111	.045
		(1.279)	(1.658)	(.9549)	(.667)	(.770)	(1.738)[c]	(1.844)[c]	(.918)	(1.249)		

Table 9 (Continued)

Regression Analysis for 132 Manufacturing Firms, 1972

	ROA	C4	NCO	GRO	DISP	CDUM	KO	RD	SIZE	CAPEF	R^2	$\bar{R}^2$
1g		.040	.0005	.015	-.742	-1.12	1.95	NA	NA	(PROD) .017	.055	.001
		(1.636)	(1.696)[c]	(1.171)	(.562)	(1.318)	(1.295)			(.774)		
1h	PCM	.060	.001	-.009	-.040	2.119	.090	NA	NA	(CAR) .063	.187	.167
		(2.223)[b]	(1.820)[c]	(.688)	(-2.468)[b]	(1.974)[b]	(4.550)[a]			(4.847)[a]		

Figures in parentheses are t-values. Significance levels for the estimated coefficients are: [a]1% level, [b]5% level, [c]10% level

on my CDUM variable is unusual. A priori, the sign of the GRO variable is ambiguous, so this difference is not so surprising. All other relationships are consistent between the two models. Allen's model is more robust in that it explains more of the variability in the model and captures more significance in the relationships. The weaker performance of my model is directly attributable to the firm based and Compustat data limitations discussed in Chapter 3.

The estimated coefficients for the C4 variables presented in Table 9 indicate a modest economic role for market power. Most studies (4:6) have found this C4 estimated coefficient to be less than .1, which indicates a slight impact on profits, so this study reinforces that finding. C4 is statistically significant at the .05 level or better in all ROA equations and one ROS equation. COGS was significant at the .01 level for both equations. Neither PROD nor CAPEF reached statistical significance at the .1 level or better in any manufacturing equation. RD, KO, DISP, and NCO were all occasionally significant.

The coefficients listed in Table 9a are elasticities for those manufacturing variables that are significant at least at the .1 level. This was done so the relative internal impacts of the different, statistically significant, variables could be compared, since they are not all measured in similar units. The C4 elasticity measure indicates that a 10 percent increase in concentration will raise profits by anywhere from 3.43 to 4.77 percent,

Table 9a

Elasticity Measures for Significant Variables
For U.S. Manufacturing Firms, 1972

Equation	C4	DISP	EFF	RD	KO	NCO
1a	.477	-.268	-1.90(COGS)			
1b	.357					
1c	.343	-.286				
1d	.380		-2.15(COGS)			
1e				.096		
1f				.095	.328	
1g						.165

depending on the model. The COGS elasticity measure indicates that a 10 percent increase in this measure will result in a 19 or 21.7 percent increase in profits, depending on whether ROA or ROS is used. This result is consistent with the large effect on profits found by the Beverly, et al., study. Since the only significant efficiency variable was COGS, it seems likely that efficiency is not well captured by this measure. If COGS was capturing the same thing as PROD and CAPEF, these variables would be more highly correlated and one would expect more uniform regression results. Since this does not occur in this study, these results tend to support the view that COGS essentially reflects factor prices, particularly labor costs. The Beverly (8) paper did not address this issue. They felt that COGS measured efficiency through cost control, but they did not examine the impact of factor prices, especially wages.

In summary, C4 plays a statistically significant role of modest economic impact in American manufacturing. For some reason, C4 explains profits slightly better when profits are expressed as ROA instead of ROS. PROD and CAPEF never reach a level of significance of .1 or better. No statistical support can be found for a significant impact for these two efficiency variables. It appears, therefore, that market power exerts some influence in American manufacturing while the role of large firm efficiency is in doubt. This result agrees in essence with Allen's (3) industry based estimates of the relative roles of market power and efficiency in American manufacturing.

The regression results for the defense related firms are presented in Table 10. The R^2 values are roughly comparable to those reported for total manufacturing, but are somewhat less than the defense work done by Allen (4) and Beverly, et al. (8). The C4 variable never becomes statistically significant in the defense related firms, indicating that it plays no significant role in their profit behavior, a result consistent with Allen (4:6). All 3 efficiency variables are statistically significant for the defense related firms, no matter how profits are measured. COGS is the more powerful indicator. Referring to Table 10a, a 10 percent improvement in COGS results in a 23.8 or 25.8 percent improvement in profits, depending on whether ROA or ROS is used. This very high economic impact is suspicious and probably occurs because COGS reflects primarily factor prices. A 10 percent improvement in PROD results in a 2.55 or 2.25 percent improvement in ROA or ROS, and a 10 percent increase in CAPEF causes a 2.18 or 2.97 percent rise in ROA or ROS. Efficiency appears to be the more important profit indicator in the defense related firms. This result also agrees with Allen's (4:13) initial results for defense related firms or industries. The high technology orientation and highly capital intensive nature of many of the firms in

Table 10

Regression Analysis for 172 Defense Related Manufacturing Firms, 1972

	ROA	C4	NCO	GRO	KO	RD	SIZE	COGS PROD CAPEF	R^2	$\bar{R}^2$
2a		-.01	-.0006	.0006	--	-.448	29.08	-16.66	.171	.142
		(.574)	(1.099)	(.398)	--	(3.479)[a]	(2.777)[a]	(5.947)[a]		
2b		--	--	.0008	--	.057	-10.322	.027	.051	.028
		--	--	(.460)	--	(.482)	(.943)	(2.578)[b]		
2c		--	-.0001	.0004	--	.051	-12.12	.029	.057	.030
		--	(2.37)	(.252)	--	(.422)	(1.122)	(2.694)[a]		
2d	ROS	-.029	-.0007	.0006	-4.50	-.383	-28.13	-15.31	.198	.170
		(1.516)	(1.257)	(.363)	(1.516)	(2.995)[a]	(2.70)[a]	(5.498)[a]		
2e		-.022	-.0002	.0007	.924	.064	-12.46	.021	.092	.061
		(1.033)	(.342)	(.426)	(1.109)	(.516)	(1.080)	(1.725)[c]		
2f		-.014	-.0002	.0003	-1.55	.092	-10.812	.033	.118	.088
		(.665)	(.320)	(.175)	(1.257)	(.812)	(.974)	(3.003)[a]		

Figures in parentheses are t-values. Significance levels for the estimated coefficients are: [a] 1% level, [b] 5% level, [c] 10% level

Table 10a

Elasticity Measures for Significant Variables for Defense Related Firms, 1972

Equation	RD	SIZE	EFF
2a	-.224	-1.215	-2.378(COGS)
2b			.255(PROD)
2c			.218(CAPEF)
2d	-.226	-1.387	-2.579(COGS)
2e			.255(PROD)
2f			.297(CAPEF)

this group (from the computer, industrial chemicals, scientific and control instruments, etc. industry groups) explain the importance of efficiency for survival and profits. Although concentration ratios are high for defense related firms, market power does not appear to play a significant role in the determination of profits. For defense related firms, the government may have effectively shut down the use of market power across many of these industry groups by using the countervailing power of the monopsonist through the contracting process.

The SIZE and RD variables become statistically significant at the .01 level for the defense related firms when COGS is in the model. Evidently, controlling for factor prices allows these two variables to surface as important predictors of profit. Referring to Table 5 we see that the correlations of SIZE with both PROD and CAPEF are fairly high. The larger firms (remember, SIZE is a reciprocal measure) tend to also have a greater value added per employee and more capital available per employee. This suggests that SIZE reflects efficiency to some degree in the defense related firms. A 10 percent increase in SIZE results in a 12.2 or 13.9 percent improvement in ROA and ROS, respectively. This fairly high economic impact probably reflects both efficiency and entry barrier characteristics embodied in SIZE. R&D expenditures appear to depress profits in the defense related firms when COGS is part of the model. A 10 percent increase in R&D

expenses results in about a 2.5 percent decrease in profits. If this relationship is not specious because of collinearity between these two measures, and the true relationship is allowed to surface by controlling for factor prices when COGS is entered, then a rise in R&D expenditures may only indicate increased competition in the defense related firms, which would deflate profits.

The regression results for the primary defense firms are shown in Table 11. The R^2 values are still lower than the defense work done by Allen (4) or Beverly, et al. (8). The C4 variable is statistically significant at the .05 level when COGS is part of the model despite the fact that the simple correlation between these two variables is .55. C4's estimated elasticity (See Table 11a) indicates that profits will rise about 15 percent in response to a 10 percent increase in concentration. COGS remains highly statistically and economically significant. The elasticity measures from Table 11a indicate that a 10 percent reduction in COGS would result in about a 65 percent improvement in profits for the primary defense firms, which is highly significant, economically. Apparently, profits are highly sensitive to wage rates and/or efficiency (since it is unclear exactly how much of each is contained in COGS). Neither PROD nor CAPEF reach statistical significance for these models. This again suggests that COGS is measuring something different from PROD or CAPEF. For this reason, market power appears to dominate efficiency

Table 11

Regression Analysis for 55 Primary Defense Manufacturing Firms, 1972

		C4	NCO	GRO	KO	RD	SIZE	COGS PROD CAPEF	R^2	$\bar{R}^2$
3a	ROA	.172	.002	-.004	---	-.103	4.144	-35.12	.332	.233
		(2.489)[b]	(1.112)	(.637)	---	(.340)	(.163)	(4.204)[a]		
3b		.084	.002	---	---	.340	43.41	.164	.118	.008
		(1.112)	(.740)	---	---	(1.016)	(1.595)	(1.522)		
3c		.094	.001	.003	---	.306	48.06	.275	.092	0
		(1.215)	(.603)	(.444)	---	(.878)	(1.610)	(.750)		
3d	ROS	.127	.002	-.005	-5.12	-.561	1.78	-28.415	.375	.282
		(2.650)[b]	(1.481)	(1.251)	(.144)	.265	(.100)	(4.880)[a]		
3e		.058	.001	-.001	.533	.296	33.34	.112	.093	0
		(1.031)	(.898)	(.248)	(.138)	(1.185)	(1.653)	(1.335)		
3f		.064	.001	---	-.71	.275	37.59	.237	.073	0
		(1.61)	(.858)	---	(.976)	(1.116)	(1.752)[c]	(.906)		

Figures in parentheses are t-values. Significance levels for the estimated coefficients are: [a]1% level, [b]5% level, [c]10% level

Table 11a

Elasticity Measures for Significant Variables For Primary Defense Firms, 1972

Equation	C4	EFF	SIZE
3a	1.481	-6.457(COGS)	
3b			
3d	1.552	-7.374(COGS)	
3f			2.705

as the more important profit indicator in the primary defense firms. However, since C4 fails to reach statistical significance in equations 3b, 3c, 3e, and 3f, this measure is not a particularly strong indicator, either. Allen (4:15) found no significant role for market power in primary defense firms, but efficiency was an important influence on profits. Our studies disagree on this point.

The regression results for the defense related firms among the "top 100" defense contractors are presented in Table 12. The R^2 values for this model vary from .55 to .73, which is somewhat higher than the R^2 figures obtained by Allen (4) or Beverly, et al. (8). The major reason for this higher explanatory power is the addition of DEF, a measure of the percentage of the firm's sales that goes to the government. The Beverly, et al., study (8) derived this variable from SEC forms 10-K, but defense sales were not available on my Compustat data. My DEF variable was constructed by dividing the value of the firm's government contracts from the _100 Largest Defense Contractors and Their Subsidiary Corporations, 1972_ by their net sales from Compustat. DEF was consistently negative and significant in this study, but when it was significant in the Beverly study, the sign was positive and the coefficients were much smaller. My study strongly indicates that higher proportions of sales to defense reduces profits. A 10 percent increase in the percentage of defense sales (See Table 12a) results in a 2.4 to 5.0

Table 12

Regression Analysis for 38 Defense Related Manufacturing Firms
Among the Top 100 Defense Firms, 1972

	ROA	C4	NCO	GRO	KO	RD	SIZE	DEF	COGS PROD CAPEF	R^2	$\bar{R}^2$
4a		.025	-.0002	-.021	NA	--	-14.33	-.078	-7.34	.563	.478
		(1.026)	(.250)	(.905)			(.331)	(2.678)[b]	(2.282)[b]		
4b		.027	-.0003	-.017	NA	.490	-11.62	-.082	.019	.550	.445
		(.991)	(.371)	(.932)		(2.129)[b]	(.166)	(3.029)[a]	(1.548)		
4c		.035	-.0001	-.016	NA	.450	--	-.085	.016	.548	.461
		(1.224)	(1.53)	(.685)		(1.884)[c]		(3.119)[a]	(1.555)		
4d	ROS	.016	.0001	-.016	3.78	--	-28.82	-.039	-8.12	.729	.666
		(.746)	(.125)	(.850)	(2.22)[b]		(.776)	(1.710)[c]	(2.748)[b]		
4e		.018	--	-.011	5.26	.423	-11.04	-.050	.009	.697	.626
		(.848)		(.586)	(3.141)[a]	(1.967)[c]	(.306)	(2.050)[b]	(.809)		
4f		.019	--	-.012	5.05	.405	-11.14	-.051	.007	.694	.623
		(.836)		(.597)	(2.574)[b]	(1.845)[c]	(.306)	(2.088)[b]	(.623)		

Figures in parentheses are t-values. Significance levels for the estimated coefficients are: [a]1% level, [b]5% level, [c]10% level

Table 12a

Elasticity Measures for Significant Variables for Top 100 Defense Firms, 1972

Equation	KO	RD	DEF	EFF
4a			-.384	-1.06(COGS)
4b		.301	-.504	
4c		.230	-.420	
4d	.483		-.239	-1.33(COGS)
4e	.672	.244	-.281	
4f	.645	.233	-.286	

percent decrease in profits, depending on the model. Garber and Poirier (37) use a dependent variable similar to DEF and also found, to their surprise, that defense sales suppress profits. It also explains why so many defense firms are diversifying into commercial markets.

Capital-output ratios were consistently positive and significant in the "top 100" defense firms. Capital intensity is an important determinant of profits in this group. A 10 percent increase in KO improves profits by 4.8 to 6.7 percent, depending on the model. KO is highly correlated with all 3 efficiency variables and may be capturing efficiency in some sense for these firms. R&D expense is positively and significantly related to profits when COGS is not part of the model. R&D is once again highly, negatively correlated with COGS, but R&D does not reach significance with COGS. A 10 percent increase in R&D expense improves profits by 2.3 to 3.0 percent, depending on the model. R&D expense appears to improve profits through lower costs in the "top 100" defense firms. Since C4, PROD or CAPEF never reach statistical significance, a clear statement about the relative impacts of market power and efficiency in the "top 100" defense firms in not feasible.

Summary

My analysis of American manufacturing finds little support for the view of Demsetz (29) and others (12, 81) that both high profits and high concentration are brought about by superior efficiency. I find some evidence in support of market power as a factor in firm profit performance, but no direct evidence of a role for large firm efficiency. To that extent, these results are broadly consistent with the results reported by Allen (3).

In contrast, market power plays no significant role in the defense related firms. Efficiency plays a larger statistical and economic role in defense related firms than in American manufacturing. No clear evidence about the relative importance of market power and efficiency came to light in the "top 100" defense firm regressions. This result agrees with Allen's initial results for defense related firms, but he went on to examine a subset of decreasing cost industries characterized by large firm efficiency. For these industries, both market power and efficiency were statistically significant and market power was the dominant influence. This approach was not feasible for my firm based data, however. Market power was again found to be the stronger influence in the primary defense firms, although the evidence here is more sparse. The percentage of a firm's sales going to defense was found to reduce profits for defense related firms.

Defense related firms, including the "top 100" defense firms are more efficient than all U.S. manufacturing as reflected in measures like PROD and CAPEF. Primary defense firms are the least efficient for all three efficiency measures. Efficiency is apparently more important to profits in defense related firms than in all of manufacturing or in the primary defense firms. A significant amount of the variation in profits for defense related firms is caused by differences in how efficient they are. More of the variation in profits for manufacturing or primary defense firms is caused by market power than by efficiency.

Recommendations

Several recommendations flow from these findings. The government should be concerned about the relative lack of profits and efficiency in the primary defense firms. A large potential for improved efficiencies and better price performance appears to exist in this area. The government should change those portions of the contracting process (discussed in Chapter 3) that allow or encourage production inefficiencies. These inefficient practices take place to a large degree because the market is structured and conducted in such a way that efficiencies do not translate to profits for the firm. The government should therefore place their emphasis, not on controlling profits, as has been the case, but on controlling costs. Higher profits for the primary defense firm caused by structural and conduct changes that allow efficiency to impact profits is a desirable outcome for the government, because lower prices may well offset the higher profits. Market power is a different matter because the defense firm will reap this extra profit with no cost benefit to the government. Any action taken to reduce or counteract market power, such as encouraging increased competition, should reduce government costs, but these actions will also reduce primary defense firm profits, which are already relatively low. Efforts to reduce or counteract market power should therefore be centered on markets with the highest concentrations and profits. The government should concentrate primarily on improving efficiency in the primary defense firms.

The situation is less serious in the defense related firms. These firms are far more efficient and this productivity plays a larger role in their profitability. Their profits are closer to those profits earned in American manufacturing. High degrees of market power in specific markets for these firms should also be countered where possible, but major structural or conduct changes designed to encourage productivity in the industry groups peculiar to the defense related groups (computers, industrial chemicals, scientific and control instruments, etc.) appear to be unwarranted. The policies of the government should therefore be tailored to the type of supplier being dealt with. The industry groups representative of the primary defense group (aircraft, communications, guided missiles, ordnance, and shipbuilding) have characteristics that are very different from the defense related or "top 100" defense firms.

The major data limitations of this study should be reviewed. All firm based studies face the problem of diversification. A firm's accounting data may be based on a number of different markets with varying characteristics. Segment or product line accounting data would present a better picture of the true structure-performance relationships, but this data is only beginning to become available. Segment based data also allows one to build a viable market share variable, which has been shown by others to be a stronger profit predictor than C4. The diversification problem was fairly limited in this study however, because most of the more highly diversified firms were not included in the data. The amount of government supplied capital was not included as part of the capital figures that made up the capital-output ratios and CAPEF. This problem primarily affected primary defense firms because this group receives most of the government capital. Wages were unavailable in my data. For this reason the amount of variation in COGS that was caused by wages was unknown. If wages could have been controlled for, the efficiency component of COGS could have been more effectively isolated. Any future work in this area should address these issues for more fruitful results.

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