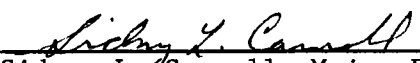


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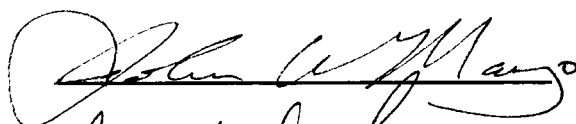


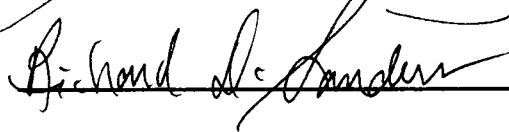
Sidney L. Carroll, Major Professor

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THE MICROECONOMIC DETERMINANTS OF CONSOLIDATED FIRM
PERFORMANCE, 1905-1915: AN EMPIRICAL ANALYSIS

A Dissertation
Presented for the
Doctor of Philosophy
Degree
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Joo-Hoon Kang

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ABSTRACT

The purpose of this study was to develop a model that can be used to examine which factors might have affected consolidated firms' performance between 1905 and 1915. It was suggested that the structural barriers to entry by industrial conditions and strategic variables designed to erect barriers to entry played a key role in determining the performance of consolidated firms. This proposition was provided with econometric evidence by use of Tobit and probit regression analysis.

This study investigated both firms that succeeded in consolidations and those that failed. To account for the inclusion of failed firms, probit and Tobit regression models were constructed for the estimation of the relationship between consolidated firms' performance and their determinants. A variety of entry-detering variables expected to influence consolidated firms' performance were discussed and tested. The structural variables expected to influence the consolidated firms' performance include vertical integration, economies of scale, capital requirements, and the extent of multiplant operation. Structural barriers to entry were measured quantitatively using Census of Manufactures (1905). The strategic variables designed to erect barriers to entry includes product differentiation, patents, and tariff protection which were evaluated qualitatively using Moody's Truth About the Trust (1904) and Manuals of Industrial Securities (1905-1915). The study has used data dealing with 228 consolidated firms in the probit model, 175 firms in the Tobit model, and 89 manufacturing industries.

The empirical results supported the proposition that structural conditions and artificial barriers to entry affected the consolidated firms' performance during 1905-1915. In particular, consolidated firms tended to be more successful when economies of scale of industry in which they were operating was larger. Consolidated firms engaged in a strategy of product differentiation could obtain significantly higher profit rates and tended to be successful.

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CHAPTER I

INTRODUCTION

In the late 19th century, the American economy experienced profound industrial changes which have been described as the great merger movement.¹ During the first half of that century, manufacturing industries consisted of small firms, and the industries were unconcentrated. This pattern changed considerably in the second half of the 19th century in two ways. First, large-scale firms were made possible by a series of technological innovations, an expansion of marketing areas, and the development of techniques for financing corporations and operating large concerns. The manufacturing sector became increasingly important in the overall structure of the economy in this period. As seen in Table I-1, the index of manufacturing production increased five-fold between 1870 and 1905. The manufacturing proportion of gross national product grew from 35.8 percent to 71.5 percent during the same period.

¹There were three major merger waves that swept through the American economy. The first occurred between 1887 and 1904, the second between 1916 and 1929, and the third between 1948 and 1975. F.M. Scherer, Industrial Market Structure and Economic Performance, 2nd ed. (Chicago: Rand McNally, 1980), pp. 119-121.

Table I-1: Growth of Manufacturing Sector

	1870	1900	1905
Indexes of Manufacturing Production (1900=100)	25	100	140
Proportion of GNP (percent)	35.8 %	76.4 %	71.5 %

Source: U.S. Bureau of Census, Census of Manufactures, vol. I, (Washington D.C.: U.S. Government Printing Office, 1905), p. xxxvi; U.S. Bureau of Census, Historical Statistics of the United States: Colonial Times to 1970, (Washington D.C.: U.S. Government Printing Office, 1976), p.231.

Second, the manufacturing sector became considerably more concentrated in this period. During the period 1897-1903, the first merger movement progressed with particular rapidity in the manufacturing sector.² (see Table I-2) In 1904, John Moody compiled a list of over 300 industrial combinations with a capitalization, as measured by the value of securities issued, of over seven billion dollars. The list contained firms that accounted for 18 percent of the total number of manufacturing plants.³

²Vernon A. Mund and Ronald H. Wolf, Industrial Organization and Public Policy (New York: Appleton-Century-Crofts, 1965), p.93. This study concerns only the manufacturing industries. But as Faulkner stated, "It should be remembered that consolidation had been going on for half a century in the steam railroads and in such public services as the telephone, telegraph, gas, and electric power and light." Harold U. Faulkner, The Decline of Laissez Faire 1897-1917, volume VII, The Economic History of the United States, (New York: Rinehart and Company, Inc., 1951), p.162.

³The Bureau of the Census recorded 296,440 manufacturing plants for the year 1900. Moody's list involved 5,288 plants.

Table I-2: Number and Capitalization of Consolidations Formed During the First Merger Movement

Year	Number	(\$:million) Capitalization ⁴
Up to 1896	61	1,005.2
1897-1904	257	6,146.1
Total	318	7,151.3

Source: Calculated from John Moody, The Truth About the Trust (New York: Moody Publishing Co., 1904), pp.453-477.

Abundant evidence on the high degree of market concentration resulting from these mergers exists. Of 92 large mergers studied by Moody, 78 resulted in control by the merged firm of 50 percent or more of the industry output, and 57 controlled 60 percent or more. Twenty-six controlled 80 percent or more.⁵ These percentages are large enough to indicate profound changes in the competitive structure of the American industry.

Many previous studies have been concerned with the factors facilitating or causing the great merger movement and with the movement's effect on the structure of industry.⁶ There have also been several attempts to investigate the performance of consolidated firms

⁴Capitalization includes stocks and bonds. The figures given are the par values. Stock watering was commonplace at the turn of the century. The figures are only approximately correct for size of consolidations.

⁵John Moody, The Truth About the Trust (New York:Moody Publishing Co., 1904), pp. 486-487.

⁶For example, Ralph L. Nelson, Merger Movement in American Industry: 1895-1956 (Princeton: Princeton University Press, 1959), pp.71-105.

following the merger movement at the turn of the century. Several early investigators attempted to determine what proportion of the mergers proved successful and which factors determine the success of the mergers.

One of the early studies of the performance of these consolidations was done by Livermore.⁷ Based on 328 companies involved in mergers during 1888-1904, Livermore's examination showed that about one-half of the consolidations not only maintained a continuous existence, but "survived" during the succeeding quarter century, while the other half failed. The main question with which this study is concerned is what factors explain the success or failure of consolidated firms in the 1905-1915 period. Several possible reasons for the success or failure of consolidated firms have been suggested. They include economies of scale, product differentiation through advertising and brand names, patents and tariffs.⁸ All of these can create effective barriers to entry into an industry. Each of the previous studies, however, has examined the issue of the relationship between firm success or failure and its determinants without the use of econometric evidence. Using econometric analysis allows a reevaluation of the significance of

⁷Shaw Livermore, "The Success of Industrial Mergers," Quarterly Journal of Economics 50 (November 1935): 68-96.

⁸Livermore, supra note; Alfred D. Chandler Jr., The Visible Hand: The Managerial Revolution in American Business (Cambridge: Belknap Press, 1977); Glenn Porter, The Rise of Big Business, 1860-1910 (New York: Thomas Y. Crowell Company, 1973); and Naomi R. Lamoreaux, The Great Merger Movement in American Business, 1895-1904 (New York: Cambridge University Press, 1985).

possible determinants of consolidated firms' performance. However, no econometric analysis has been done.

Purpose and Organization

The purpose of this study is to analyze the performance of consolidated firms between 1905 and 1915 and the determinants of that performance using the structure-conduct-performance paradigm. For this analysis, probit and Tobit regression models are employed.

This study is organized as follows. In Chapter II, previous research work on the performance of consolidated firms is examined as well as the relevant work concerning the industrial organization approach used here. Case studies on the effect of the major variables on the performance of consolidated firms are also presented. In Chapter III, the empirical regression model used in this study is presented along with a discussion of the data used in this study and the variables included in the model. The empirical results of the model are given in Chapter IV. The conclusions are provided in the final chapter.

CHAPTER II

REVIEW OF THE LITERATURE

Previous Studies of Consolidated Firm Performance

Several attempts have been made to measure the success of the early mergers in terms of their relative profitability. Arthur S. Dewing selected 35 prominent consolidations organized between 1893 and 1902 for examination.⁹ His findings about these consolidated firms were twofold. First, the average earnings of constituent firms in the years prior to consolidation exceeded the first year earnings of the consolidated firms by 18 percent. The same measure shows that premerger earnings were a fifth and a sixth greater than the average earnings of the ten years following consolidation. Second, consolidated firms' estimates of prospective earnings exceeded the actual earnings of the first year by 50 percent and exceeded the average earnings during the ten-year period following consolidation by 175 percent. In only five consolidations did the average earnings for the ten-year period following consolidation equal or exceed the estimates made by consolidated firms at the time the merger was organized. From his findings, Dewing concludes that consolidations as a whole were not particularly successful. One criticism of Dewing's analysis is that his conclusions were based on a sample of 35 mergers--less than one-tenth of the number of mergers known

⁹Arthur S. Dewing, "A Statistical Test of the Success of Consolidations," Quarterly Journal of Economics 36 (November 1921): 84-101.

to have occurred between 1890 and 1904. It has been pointed out that the selection of industries in Dewing's sample was heavily weighted with industries for which the long-term influence had not been favorable.¹⁰ Dewing's findings, based on the small and biased sample, therefore may not reflect accurately the record of merged firms.

A more comprehensive study of the profitability of consolidations was made in the analysis of Livermore.¹¹ He collected information on 328 companies involved in mergers during 1888-1904 and classified the firms into a primary group and a secondary group. Livermore characterizes the primary group as "mergers with power enough to influence markedly conditions in their industry." The secondary group includes the companies that did not achieve a high degree of market control although formed by merger.

As seen in Table II-1, Livermore's judgement was that in the primary group 40.4 percent of the firms were failures, 10.9 percent were marginal successes, and 48.7 percent were successes. In the secondary group, 45.3 percent were classified as failures, 6.4 percent as marginal, and 48.3 percent as successes. From Livermore's findings, it is evident that successes and failures were approximately evenly distributed in both primary and secondary groups. That is, the consolidated firms in the primary group (those firms that had achieved a high degree of market control through mergers) were not more successful

¹⁰Fred J. Weston, The Role of Mergers in the Growth of Large Firms (Berkeley and Los Angeles: University of California Press, 1953), p.68.

¹¹Livermore, "The Success of Industrial Mergers," p.78.

on the average than those of the secondary group. This result implies that the degree of market control was not a significant factor in determining the successes or failures of consolidated firms.

Table II-1: Livermore's Classification of 324 Consolidated Firms' Performance

	The Primary Group (156 firms)	The Secondary Group (172 firms)
Successes	48.7 %	48.3 %
Marginal	10.9 %	6.4 %
Failures	40.4 %	45.3 %

Source: Shaw Livermore, "The Success of Industrial Mergers," pp. 75-77.

While Livermore was principally concerned with measuring the financial success of mergers, he made some observations on why they were successful. Livermore observed that there were reasons for success other than the degree of market control gained by a merger. His study shows that 146 out of a total of 328 mergers were successful. Of these successful mergers, 130 owed their success to product differentiation by advertising intensity, continuous improvement of marketing method and manufacturing organization, the possession of patent rights, and vertical integration to effectively meet the problems of raw material supply markets and transportation costs. The remaining 16 owed their success to monopoly control or "unfair and vexatious practice."¹²

According to Chandler, technical progress played a key role in

¹² ibid., 87-90.

pushing firms toward greater capital intensity and greater ranges of economies of scale, thus leading to larger firms. The development of railroads and communication made mass distribution possible. Technical progress led to more capital-intensive operations which made mass production possible, which in turn resulted in modern large firms. The modern industrial enterprise, therefore, represents the integration within a single firm of the process of mass distribution with that of mass production.¹³ Chandler argued that there were both fewer consolidations and more failures at consolidation in industries that experienced little or no capital-intensive technical change and thus remained relatively labor-intensive. Chandler also found that successful consolidated firms were most numerous in the high-volume, large-batch, or continuous-process industries and in those which required capital-intensive, energy-consuming technologies, and special marketing services.¹⁴ For Chandler, the main point is that industrial conditions played a key role in determining the consolidated firms' performance.

The question of how industrial conditions affected the firms' performance can be answered by examining the entry barrier effect of industrial conditions. It seems safe to argue that structural barriers to entry by industrial conditions protected existing firms from the potential competition and permitted the protected firms to be more

¹³ Chandler, The Visible Hand (Cambridge:Belkap Press, 1977), p.285.

¹⁴ ibid., 337-338.

profitable over time. Glenn Porter describes this argument,¹⁵

The difficulty and expense of creating new, competitive firms in such industries as steel, nonferrous metals, petroleum, autos, rubber, machinery,... and chemicals usually either discouraged most outside competitors from venturing into those areas....

In some industries that involved little in the way of advanced technology, big business discouraged competition through heavy advertising and brand names.

As Porter noted, in some industries that did not generate structural barriers to entry, the strategic behavior of consolidated firms was an effective determinant of the firms' success. On this point, Lamoreaux argued that the success of consolidated firms was derived from something other than an advantage in costs over their rivals--the exploitation of artificial barriers to entry caused by strategic behavior.¹⁶ In her examination of United States Steel Company, Lamoreaux found no evidence that additional production economies resulted from further integration backward into ore mining. Instead, she found considerable evidence that the U.S. Steel's acquisition of ore lands was part of a complex strategy of market control. For example, U.S. Steel's holdings of 70-75 percent of iron ore in the Lake Superior region enabled the corporation to effectively prevent the emergence of new competitors and to limit the expansion of existing rivals. Control of ore resources helped U.S. Steel limit the entry of less vertically integrated competitors and helped them earn

¹⁵ Glenn Porter, The Rise of Big Business (New York: Thomas Y. Crowell Company, 1973), p.81.

¹⁶ Naomi Lamoreaux, The Great Merger Movement (New York: Cambridge University Press, 1985), p.142.

high profits.¹⁷ Lamoreaux further pointed out that many other consolidations made attempts to protect their positions by erecting barriers to entry. Those attempts include patents, tariff protection, and product differentiation. For example, many large-scale firms that produced consumer goods, such as National Biscuit, Corn Products Refining, Quaker Oats, American Tobacco, and General Electric Company were successful concerns which engaged in massive advertising in the early 20th century making it difficult for new firms to enter the market.¹⁸

There are, therefore, two types of barriers: artificial barriers to entry resulting from strategic use of barriers to entry and structural barriers to entry caused by industrial conditions. Both barriers to entry contributed to the consolidated firms' performance. How barriers to entry can play a role in determining the firms' performance is discussed in the next section.

Structure-Conduct-Performance Approach

According to the traditional paradigm, the structure of an industry (the degree of concentration and the conditions of entry) determines the conduct of firms (price and non-price behavior) within the industry which, in turn, determines the performance of the industry (profits, innovation, etc.). The conduct of firms is expected to be constrained

¹⁷ ibid., 146-147.

¹⁸ ibid., 157.

by the structure of their industry. For example, firms in a structurally-competitive industry which is characterized by a large number of firms of roughly equal size, with free entry into the industry, have few options for conduct. The competitive structure of the industry determines whether the firms will be price-takers and cost minimizers. In the long run, equilibrium price equals marginal costs, and profits are at a normal level. However, firms in highly-concentrated industries protected by barriers to entry can, through collusion, take advantage of variety of conduct options involving pricing, product strategy, and research and innovation. The outcome is that price is above marginal cost, and there are supra-competitive profits.

One of the key structural characteristics of an industry is the extent to which barriers to entry exist in industry. In his examination of 20 United States manufacturing industries, Bain introduced the concept of barriers to entry as an element of market structure.¹⁹ According to Bain, the condition of entry determines the extent to which established firms can set prices above competitive levels without inducing entry.²⁰ Bain classified entry barriers into four main sources: absolute cost advantages, economies of scale, capital requirements, and product differentiation.²¹

¹⁹ Joe S. Bain, Barriers to New Competition (Cambridge: Harvard University Press, 1956).

²⁰ Ibid., 254-255.

²¹ Ibid., 15-16.

Absolute cost advantage barriers exist when established firms have lower costs at every level of output than potential entrants. Absolute cost advantages can result from several sources: exclusive control of production techniques (e.g. patent holding), exclusive ownership of scarce resources, and capital market advantages in the form of lower interest rates. The operation of an absolute cost advantage barrier to entry is illustrated in Figure II-1.

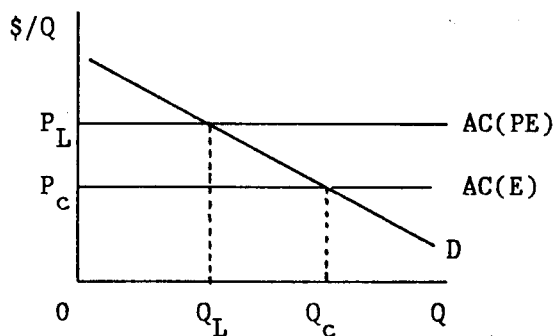


Figure II-1: Limit Price Model by Absolute Cost Advantage

The line labeled $AC(E)$ represents the level of average costs by existing firms. The line labeled $AC(PE)$ represents the level of average cost by disadvantaged potential entrants. Given the level of market demand, existing advantaged firms would, in the absence of collusion, expand output to the competitive level (OQ_c), where price equals average cost. However, their cost advantage provides an opportunity for existing firms to collusively restrict output to slightly more than OQ_L and set price just below OP_L in order to obtain economic profit. The ability of the existing firms to persistently charge a price above the competitive level (OP_c) depends upon the extent of their cost advantage over entrants, which is given by the vertical distance between $AC(PE)$

and $AC(E)$.

Economies of scale can also act as a barrier to entry under certain assumptions. The simple model is presented in Figure II-2. This model incorporates three assumptions. First, there are increasing returns-to-scale up to a level of output which is significant relative to the total market size. Second, existing firms maintain their output in the face of new entry, and potential entrants know this. This assumption has been referred to as the Sylos Postulate. Third, potential entrants have access to the same long-run average cost curve as existing firms. Under these assumptions, the limit price model explains how existing firms can earn a profit above the normal level without inducing entry into industry.

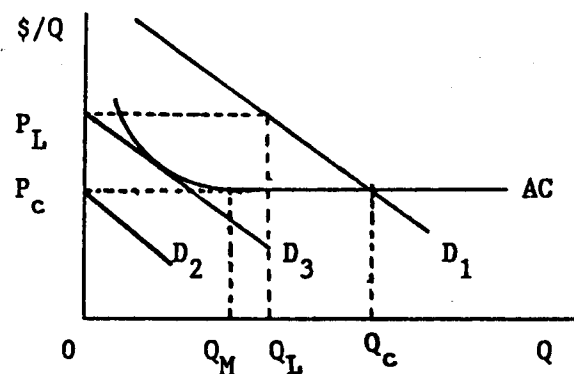


Figure II-2: Limit Price Model by Economies of Scale

Q_M : Minimum efficient scale

D_1 : Market demand curve

D_2 : Demand facing entrants, if existing firms produce output of Q_C

D_3 : Demand facing entrants, if existing firms produce output of Q_L

P_L : Limit price

OP_c : Competitive price

Suppose existing firms produce OQ_c output and price is OP_c . Then the demand curve facing entrants (D_2) is below the long-run average total cost of entrants, so entry is discouraged. With this advantage, existing firms can set price to OP_L by producing output of OQ_L . In this case, the demand curve facing entrants is D_3 which is tangent to the long-run average total cost of entrants, and entrants will just cover their costs. In view of this, existing firms can maintain output at slightly more than Q_L and charge a corresponding price just below OP_L . Thus existing firms can earn a profit above the normal level without inducing entry into industry.

In the context of economies of scale, Modigliani derived the limit price. That is, $P_L = P_c (1 + 1/e \cdot s)$ where e is elasticity of demand in the region of P_c , and s is the ratio of competitive output (OQ_c) to the minimum efficient scale (OQ_M). Limit price tends to increase with the minimum efficient scale and to decrease with the size of market and the elasticity of demand.²²

It has been recognized that existing firms can deter entry by adopting a limit pricing strategy. However, there have been several theoretical criticisms of the limit price theory. First, the theory has been criticized because of its static nature. The firm's decision is strictly dichotomous--either maximize short-run profits and earn less

²²F. Modigliani, "New Developments on the Oligopoly Front," Journal of Political Economy 66 (June 1958): 215-232.

later due to entry or forego a portion of short-run profits and forestall entry so that more might be earned later. Dynamic pricing models begin by assuming the dominant firm will choose the price strategy that maximizes the net present value of its future profits stream. The short-run profit maximization and limit price strategies are only two of many possibilities. For example, the firm's optimal strategy might involve pricing above the limit price but below short-run profit maximization and allow its market to gradually fall.²³ The fundamental point is that a dominant firm may rarely find its most profitable strategy as either being short-run profit maximization or strict adherence to conventional limit pricing.

Another major criticism concerns the model's assumption of the Sylos Postulate: The entrant assumes that the established firms will maintain their output in the face of potential entry, and the established firms know this to be the case. Under many conditions it is unrealistic for existing firms to maintain output after entry, and an entrant who knows this is not deterred by threats to do so. The Sylos Postulate is not a credible threat for large-scale entrants. Firms can engage in a number of alternative strategic behaviors yielding credible threats of entry deterrence. Entry-detering investment strategies designed to increase future profits include investment in capacity (Dixit (1979), and Spence (1980)), R&D (Gilbert and Newbery (1982)),

²³Darius W. Gaskins, Jr., "Dynamic Limit Pricing: Optimal Pricing under Threat of Entry," Journal of Economic Theory 3 (September 1971): 306-22.

brand introduction (Schmalensee (1978)), and vertical integration.²⁴

Spence has suggested that the dominant firm might use excess capacity to deter entry. The dominant firm could price above the average cost of potential entrants so long as potential entrants perceive that post-entry price will be lower than pre-entry price. This strategy requires the dominant firm to respond by expanding output. Similarly, product differentiation strategy may be designed to deter potential entrants. Intensive advertising can create heightened brand loyalty and thereby increase the extra outlays a new firm must make in order to offset incumbent firm's advantages. In his study of the breakfast cereal industry, Schmalensee (1978) argues that established brands may earn excess profits while entry remains unattractive. If established firms crowd the economic space prior to the threat of entry, it serves as a deterrent to entrants. A strategy of vertical integration is also suggested as another barrier that raises investment. When existing firms integrate one stage forward or backward, they pose a dilemma for the new entrants considering entry at either stage. If the entrant enters unintegrated, he faces bargaining disadvantages of

²⁴However, there is considerable disagreement on the definition of barriers to entry and on what constitutes the sources of barriers to entry. For example, some economists criticize the argument that economies of scale represent a barrier to entry. For Stigler, economies of scale do not constitute a source of barriers because scale economies are equally available to all firms, including potential entrants. In the theory of contestable markets, zero-sunk costs are assumed, so that exit would be costless, and strategic entry deterrence is impossible. William J. Baumol, John C. Panzar, and Robert D. Willig, Contestable Markets and the Theory of Industry Structure (New York: Harcourt Brace Jovanovich, 1982).

uncertainty and transaction costs in market transactions. Thus, multistage entry may be necessary to avoid disadvantages. However, the enormous amount of capital that this multistage entry requires constitutes a powerful discouragement to new competition.²⁵

There are two essential requirements for strategic behaviors of this kind. First, the commitment should be made prior to the entrant's decision. Second, strategic behaviors require irreversible commitment. Irreversibility has led to a greater appreciation of the importance of sunk costs. What matters is the degree to which costs are irrecoverable, rather than the relationship between unit cost and output. For example, capital goods that depreciate rapidly are not useful investments for an entry-detering commitment.²⁶

Firms try to build barriers against entry into their industry in order to protect their future position. Strategic entry-detering investments are made to increase the height of existing structural barriers or to make credible the threat of retaliatory action against potential entrants.

On the empirical side, many studies have established an explicit link between market structure and performance through conduct.²⁷ The

²⁵Roger D. Blair and David L. Kaserman, Law and Economics of Vertical Integration and Control (New York: Academic Press, Inc., 1983), pp.42-47.

²⁶A. Dixit, "Recent Developments in Oligopoly Theory," American Economic Review 72 (May 1982): 13.

²⁷For a comprehensive survey, see Weiss (1974), Pautler (1983) and Scherer (1980). Which variable to use and how to measure each variable in this study will be discussed in detail in Chapter III.

traditional school of thought in the industrial organization field is that a positive relationship exists between concentration and barriers to entry and performance, where performance is measured by profitability.²⁸ The positive relationship links concentrated markets with barriers to entry and profit above the competitive level. The basic premise is that concentrated markets are likely to foster collusion by firms to increase price above the competitive level so that the firms in concentrated markets tend to earn above-normal profit. In these studies, barriers to entry are a crucial additional aspect of market structure, as Mann found that the effect of concentration on profitability was significantly greater in the presence of high barriers to entry. There is, however, a school of thought which puts quite a different interpretation on observed links between structure and performance. For example, Demsetz argues that above-average profits of large firms could arise either from superior efficiency or from successful collusion. If profit rates arise from collusion, Demsetz also argues that small firms operating in concentrated industries should benefit from a pricing umbrella effect established by large-firm pricing behavior. Demsetz found that the profit rates of small firms do not rise with concentration, and that the link between concentration and

²⁸Joe S. Bain, Barriers to New Competition (Cambridge: Harvard University Press, 1956) and "Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936-1940," Quarterly Journal of Economics 65 (August 1951):293-324.; and H.M. Mann, "Seller Concentration, Barriers to Entry and Rates of Return in Thirty Industries, 1950-60," Review of Economics and Statistics 48 (August 1966): 296-300.

profitability is a large-firm phenomenon. He concluded that large firms are more efficient than their smaller rivals so that "efficient structure hypothesis" was a better explanation of the positive correlation between concentration and profitability.²⁹

The debate on the relationship between industrial concentration and efficiency has been inconclusive. From the point of view of those who adopt the "efficient structure hypothesis" consolidated firms are successful simply because they have a comparative advantage in production and in organization. There are, however, difficulties in distinguishing between the effects of efficiency and of market power in empirical research in the absence of relative cost data.

A recent empirical study concerning the relationship between firm performance and entry barriers was made by Caves et al.³⁰ Their argument is that higher structural entry barriers generally result in both higher profits and a slower sacrifice of market share. They examined the Gaskins' dynamic limit pricing model according to which: "A long-run equilibrium market share is determined for the dominant firm by its cost advantages against actual or potential rivals (or both)." In their model, the declining market share during 1905-1929 and the profit rates earned during 1905-1915 are used as dependent variables representing the performance of 39 dominant sample firms created by

²⁹Harold Demsetz, "Industry Structure, Market Rivalry, and Public Policy," Journal of Law and Economics 16 (April 1973): 1-10.

³⁰Richard E. Caves et al., "The Decline of Dominant Firms, 1905-1929," Quarterly Journal of Economics 99 (August 1984): 523-546.

merger and consolidation in the United States at the start of this century. Several independent variables assumed to affect firm performance were economies of scale, capital requirements, product differentiation, vertical integration, patents (which are entry-detering variables), growth rate of industry, and tariff protection. Caves et al. found that entry-detering variables proved to be important determinants of firm performance. Their regression results seemed to be consistent with the hypothesis that dominant firms use a strategy of dynamic limit pricing.

A review of the literature leads to the conclusion that barriers to entry can be key determinants of firm performance. The determinants of consolidated firms' performance are examined here within the structure-conduct-performance paradigm. Structural elements, in addition to economies of scale, that contribute to barriers to entry are: capital cost requirements, vertical integration of industry, and initial market share. High-volume, large-batch, high-technology industries are expected to realize large economies of scale and require large capital costs. Each of these factors could lead to substantial barriers to entry in those industries. Continuous-process industries and those needing special services would lead to a high degree of vertical integration of industry which also is a source of barriers to entry. In conduct, massive advertising, patents, and tariffs are strategic ways by which firms can deter entry. The structural barriers and artificial barriers created by conduct protect consolidated firms from potential competition and help the firms to be successful. In the next section, case studies of consolidated firms are presented in terms

of this structure-conduct-performance paradigm.

Case Studies of Consolidated Firms ³¹

The United States Leather Company

In 1893 the United States Leather Company was formed for the purpose of combining the principal tanning companies making sole leather. The chief economic reason for the formation of U.S. Leather was to avoid severe price competition and to obtain the economies of scale that organizers believed possible with large-scale production. The price of sole leather had fallen steadily from 1884 to 1891, and competition among the tanners was growing increasingly unstable. By 1893 there were signs of marked over-production. As a result, the large tanners entered into an agreement to reduce their output. At first, the collusion worked well but was doomed to failure over time due to several problems. First, some producers stayed out and undermined the cartel. Second, there always existed the incentive of extra profits for existing firms to cheat on the prearranged agreement. Third, the successful cartel quickly attracted new producers into the industry, which brought prices and profits down again. Furthermore, the Sherman Act became law in 1890. The failure of collusion led to a search for a new way, that

³¹Much of this section is based upon Arthur S. Dewing, Corporate Promotions and Organizations (Cambridge: Harvard University Press, 1914), especially Chapters II and V; Victor S. Clark, History of Manufactures in the United States, Vol. II and III (New York: McGraw-Hill, 1929); and Harry W. Laidler, Concentration of Control in American Industry (New York: Crowell, 1931).

is, it led horizontal combination.³²

The widely recognized success of the oil, whiskey and sugar combinations encouraged the large tanners to consider the possibility of obtaining economies of scale by merging their different interests into one company. In this way, U.S. Leather acquired approximately 110 tanners, controlled by some 60 leather houses. At its formation in 1892, U.S. Leather's market share of the sole leather tanned domestically was about 58 percent. U.S. Leather had the largest book capitalization (\$131,000,000) of any American industrial corporation (cf. the American Sugar Refining Co.: \$75,000,000, the American Tobacco Co.: \$35,000,000 and the United States Rubber Co.: \$50,000,000).³³ The large market share gave the leaders of the enterprise confidence that they would earn large profits and justified the high value that they placed on their assets. Because the leaders believed that the low price of the finished product was directly attributable to the severe competition, they confidently expected that when the economies of combination had been introduced, a period of high prices and trade prosperity would necessarily follow. In addition, they believed that

³² According to the Sherman Act, cartel behavior (price-fixing) was per se illegal while horizontal combination was subject to a rule of reason. Some have argued that this asymmetry encouraged mergers rather than collusion. George Bittlingmayer, "Did Antitrust Policy Cause the Great Merger Wave?," Journal of Law and Economics 28 (April 1985): 77-118.

³³ The property acquired by the United States Leather Company had an assessed market value of \$60,000,000. Against these assets the company issued \$131,000,000 of securities (common stock:63,000,000; preferred stock:62,000,000; bonds:6,000,000).

they would achieve large economies by reducing the number of salesmen and subagencies and by closing tanneries less-advantageously situated.

In spite of their expectation, however, the immediate result of the combination was failure, which finally ended in the reorganization of the U.S. Leather Company into the Central Leather Company in 1905. Several reasons for the failure of the U. S. Leather Company may be considered. The first is the general business depression which prevailed immediately after its consolidation. The first four to five years following the panic of 1893 were characterized by a marked industrial stagnation. At a time of falling prices, the price of hides lagged behind that of leather because the production process between the purchase of hides and actual sale of the finished leather to the domestic consumer required a time from six months to a year. As a result, the company was compelled to sell leather for less than its cost of production. Additionally, U.S. Leather was burdened by the large amount of land it owned and against the estimated value of which it had issued preferred stock with 8% dividends to be paid from the net earnings of the business.

Another reason for the failure lay in the highly-competitive characteristics of the leather industry. Only a small amount of capital for plant and equipment is required in proportion to output. The raw materials of the industry (hide and bark) are purchased in a highly-competitive market. From the beginning, the leather combination had weak control over the market in which it bought its hides. No large amount of skilled labor is required in the industry, since the tanning of hides is a long-term process in which the cost of labor is

subordinate to the cost of the raw material. The advantageously-located small tanner can, indeed, tan hides quite as cheaply as the large tanner. Under these conditions, it would seem that U.S. Leather could derive little advantage from consolidation.

The National Cordage Company

The spinning of rope was among the first industries set up in colonial days. In this early period, rope making was dependent on the business of shipbuilding, so that with the gradual decline of the latter industry, ropemaking became relatively unimportant. After the invention of the self-binding harvester machinery, a sudden stimulus was given to the industry through the increased demand for binder's twine.

To overcome problems of overproduction and falling prices, manufacturers of cordage (rope and twine) formed associations and pools in the 1870s and 1880s. These combinations, however, did not bring the stability and security the producers wanted. In 1887, four of the leading companies took the next step--uniting to form the National Cordage Company with the idea of reducing the cost of production by combining plants and stabilizing raw material prices by eliminating competition. In an attempt to gain control of the industry, National Cordage started with an ambitious program of expansion. In the summer of 1890, the capital stock of National Cordage was increased from \$1,500,000 to \$15,000,000, and more competitors were brought into the combine. The objective of the enlarged activity was to attain actual control over the industry. To accomplish this end, National Cordage became aggressive in three directions. First, they sought to control the market on raw hemp. Second, they sought to control the manufacture

of cordage-making machinery. Third, they sought to buy up all the competing cordage mills. In the spring of 1892, the company's position was dominant in the market both for raw hemp and manufactured cordage. The company controlled approximately 90 percent of the cordage mills in the country. The nation's leading financial journal, the Commercial and Financial Chronicle, referred to National Cordage as the "great industrial corporation." Surprisingly, three months later, the journal announced, "Cordage has collapsed like a bursted meteor." This sudden failure was partly due to faulty methods of organization. The company bought all the raw materials for various concerns which it controlled and sold their products, but the constituent firms preserved their identity and a certain amount of operational autonomy. This kept the consolidation from realizing all the economies of scale it originally contemplated.

The weakest point of the combination, however, was its inability to control new competition. As rapidly as the officials of the company would buy up the competing mills, the old owners, either in their own name or as representatives of others, would start to build new mills. This illustrates the inherent difficulty of acquiring and maintaining monopoly of production in an industry where there are low barriers to entry into the industry. In the winter of 1892 and spring of 1893, in the face of increasing competition, National Cordage manufactured very large quantities of binder twine and something more than the normal production of rope. Unable to carry the financial burden coming from an over-supply of raw material and finished product, with its trade position undermined by new competitors, the consolidation collapsed in a

receivership. After its failure, National Cordage was reorganized as the United States Cordage Company and again reorganized as Standard Rope and Twine Co., all the while with a considerable reduction of assets and capitalization. Like the leather industry, the cordage industry was competitive and open to all. The raw material was bought in an open competitive market and the finished product was sold under conditions of competition. Under these circumstances, there was no advantage to consolidation in this industry.

The United Shoe Machinery Company

In February 1899, the United Shoe Machinery was organized as a consolidation of five shoe machinery manufacturers. Each constituent company produced different types of machines and were dominant in their respective branches of the industry. Thus the merger achieved a very high degree of market control in the major fields of shoe machinery. It seems safe to say that the new company's market share was 70 percent or greater. Following the merger, United Shoe substantially controlled the shoe machinery business of the United States and was successful. By 1910, the total assets of the company had reached \$40.8 million which represents an annual rate of growth of nearly 10 percent. This growth was financed from earnings of the business; over the period 1905-1915 the average annual profit rate on total capitalization was 14.25 percent. About half of this was paid out in dividends, and half was reinvested. This success can be explained in several ways. The success came from a series of acquisitions of business, patents, and inventions. Though the company was powerful, it was constantly threatened by the invention of new types of shoe machinery; frequently it was forced to

buy out such potential competitors. From 1899 to 1911, United Shoe concluded 59 acquisitions of one sort or another. For example, from the acquisition of Thomas G. Plant Shoe Co., made in September 1910, the United Shoe received 206 patents, 28 patent applications, and machine tools. The company also created an experimental department. Expenditures for research averaged about \$0.5 million per year. About 150 new machines were brought out in the period 1899-1914. Second, the company concentrated all manufacturing activities in one new plant in Beverly, Massachusetts, and it created a service organization. By 1911, the service department employed over 600 men, had 27 branch organizations in 13 states, and had an annual operating expenditure of \$1.2 million. United Shoe continued the practice of its major predecessors of leasing rather than selling most of its machines.

One reason United Shoe was successful in creating barriers to entry was that the major machines they produced were not easily substituted. That is, there were no close substitutes in production--shoe machinery manufacture presents a special problem of precision and complexity. The demands in terms of knowledge of the shoe-making art and manufacturing technique, which potential competitors in major machinery must meet, are high. In his testimony Wilson Palmer, United Shoe Vice-President describes this point, "The manufacturing technique required in making a wide line of shoe machines is, in general, more advanced than that required in other branches of the machinery industry; the problems presented by the diversity and complexity of parts in each machine are

unusual."³⁴

It seems fair to conclude that no competitors could offer a significant competitive threat to United Shoe or act as a substantial check on United Shoe's power in the market. The leasing system, United's patent structure, and accumulated know-how in research all contributed significantly to United Shoe's market power.

The National Biscuit Company

In the 1898, the New York City Biscuit Co., The American Biscuit and Manufacturing Co., The United States Baking Co., and the United States Biscuit Co. consolidated as the National Biscuit Company with total capital of \$55,000,000, controlling 40-70 percent of the cracker and biscuit trade in the country. National Biscuit was a successful merger; it maintained its market share and made high profits (9.31%) between 1905 and 1915. Like the leather industry, the baking and bread industry does not require complex technology and capital intensity which could have caused high barriers to entry into the industry. In the face of few natural advantages deriving from industry conditions, if the company had attempted to maintain its horizontal combination by cutting prices or buying out competitors, it might have been a financial failure like National Cordage. National Biscuit realized the need for a change in strategy. In spite of large market share of the baking business which it had, the first report of the president stated: "We have no

³⁴Carl, Kaysen, United States vs. United Shoe Machinery Corporation: An Economic Analysis of an Anti-Trust Case (Cambridge: Harvard University Press, 1956), p.54.

monopoly.... We always expect to have a great deal of competition. We propose to get the business and to hold it by selling better goods, by furnishing them in a better condition to consumers and at lower prices... than our competitors are able to do."³⁵ National Biscuit, renamed Nabisco, started out with a new policy to differentiate its products instead of producing in bulk for the retailers' cracker barrels. Nabisco did this by extensive advertising and distributing products in attractive sanitary packages using the brand name "Uneeda Biscuit." The words "Uneeda Biscuit" were outstanding brands and became the controlling factor in the biscuit and cracker trade.

In reviewing two successful firms and two failed firms, it is clear that structural conditions of industry were important determinants influencing their performance. See Table II-2 for a summary of these cases. National Cordage and U.S. Leather suffered from the presence of competitors in spite of their efforts to control competition. In both the leather and cordage industries, consolidations could not generate economies of scale from large-scale production. The managers of the consolidated firms could not control both the raw material market and the output market. Glenn Porter describes this point, "The supply of raw materials was abundant, the cost of beginning production was low, and no control was possible at the marketing end of the business. The appearance of competitors broke prices and often resulted in the

³⁵Clark, History of Manufactures (New York: McGraw-Hill, 1929), p.269.

collapse of the combine."³⁶

Table II-2: Summary of Case Studies Concerning Consolidated Firms

Company	Industry	Profit	Structural Barriers	Artificial Advantage
U.S. Leather	leather, tanning	failure	low	
National Cordage	cordage and twine	failure	low	
United Shoe Machinery	foundry and machine shop	14.25% ^a	high	patents
Nabisco	bread and bakery	9.31% ^a	low	trademarks

^a Profit is average annual rate during 1905-1915, calculated from Moody's Manuals of Industrial Securities.

By contrast, the shoe machinery industry required complex technology which created high barriers to entry into the industry. This technical barrier to entry protected United's market position from the potential competition. United Shoe could also obtain cost advantages as a result of patent protection and superiority in production know-how. In the baking and bread industry, horizontal combination did not lead to realization of economies of scale and was not enough for its success. Nabisco's success resulted from advantages gained through product differentiation by extensive advertising.

The question of why some consolidated firms were successful while

³⁶ Glenn Porter, The Rise of Big Business (New York: Thomas Y. Crowell Company, 1973), pp.81-82.

others were not was important in earlier studies of the first merger movement. Several reasons for the success of consolidated firms were suggested. The suggestion was that structural and artificial barriers to entry affected the consolidated firms' performance. Case studies seemed to support this proposition. However, little econometric work has been done to add evidence to the case. The purpose of this study is to provide econometric evidence on the proposition. The econometric analysis, methodology, and data will be discussed in the next chapter.

CHAPTER III

MODEL AND METHODOLOGY

The first part of this chapter presents the statistical equations used to estimate and evaluate the relationship between consolidated firm performance and its determinants. The second section discusses the issue, definition, and measurement of variables to be included in the model. Probit and Tobit regression models are presented and discussed, with focus on the Tobit model, in the third section, followed by the discussion of data to be used in the regression analysis.

Empirical Model

In order to test determinants of consolidated firms' performance, it is useful to classify the variables used in the present regression analysis into three groups: entry-deterring variables reflecting industry characteristics, strategic variables designed to erect barriers to entry, and others (industry growth rate and initial market share).

The structural variables expected to influence the consolidated firms' performance(R) include vertical integration of industry(VIS), economies of scale(MES), capital cost requirements(K), and the extent of multiplant operation(MP). The second group of variables are strategic ones designed to erect barriers to entry by product differentiation strategy(PD), preemptive patents strategy(PAT), and tariff protection strategy(TA). The other variables to be included are the growth rate of industry(GR) and initial market share(IMS).

The general form of the model to assess the relative importance of

various determinants of the success or failure of the consolidated firms is as follows:

$$R = f (VIS, MES, K, MP, PD, PAT, TA, GR, IMS)$$

where R : Consolidated firms' performance
VIS : Vertical integration of industry
MES : Economies of scale
K : Capital cost requirements
MP : Multiplant economies of scale
PD : Product differentiation
PAT : Preemptive patent
TA : Tariff protection
GR : Industry growth
IMS : Initial market share

The model is designed to test whether and to what extent structural barriers and artificial barriers to entry erected by a firm lead the firm to be successful. To the extent that barriers protect the existing firms from potential entrants, it is likely to be reflected in supra-competitive profits of consolidated firms. The definition and measurement of those variables is controversial. The next section will discuss the issues surrounding the definition and measurement of variables to be included in the regression model.

Discussion of Variables and Measurement

Dependent Variable (R)

The dependent variable (R) represents consolidated firm performance which is a measure of firm success or failure. Firm profit is used here as a measure of consolidated firm performance. Profit rates are measured, as Livermore measured them, by calculating net earnings (or net income) after tax and charges for depreciation to equity.³⁷

Vertical Integration (VIS)

The potential impact of vertical integration on barriers to entry has been a topic of debate for a long time. Some economists (Bork, 1969) argue that vertical integration by existing firms cannot possibly deter entry, while other economists (Comanor, 1967 and Williamson, 1979) say vertical integration can increase the entry barriers faced by potential new firms. Here vertical integration will be considered as a possible barrier, because it tends to raise investment necessary for entry.³⁸

Widespread forward or backward integration by existing firms can force new firms to enter both stages simultaneously. This simultaneous entry may impede entry by increasing the capital requirements of potential entrants.

No generally-accepted method to measure the degree of vertical

³⁷ Livermore, "The Success of Industrial Mergers," Quarterly Journal of Economics 50 (November 1935):79.

³⁸ Richard E. Caves and Michael Porter, "From Entry Barriers to Mobility Barriers," Quarterly Journal of Economics 91 (May 1977): 244.

integration has emerged. One possible measure is the ratio of value added to sales ratio proposed by M.A. Adelman (1955). Scherer has criticized this ratio by pointing out a problem: that is, "the nearer the raw materials' end of the production stream firm's operations are located, the higher its value added to sales ratio tends to be."³⁹ Because of this bias, measurement results must be viewed with caution.

Economies of Scale (MES)

Economies of scale are thought to be a barrier to entry according to the Sylos-Bain model (Modigliani, 1958). If the minimum efficient scale of a plant is large relative to the size of the market, and the disadvantage of a less-than-optimum size operation is substantial, established firms can deter entry by setting price and quantity at the entry-detering level. Minimum efficient scale (MES) is usually used as a proxy for economies of scale in regression analysis. Three methods to measure MES have been suggested. First, there is the engineering method pioneered by J.S. Bain. This is not available for the early 20th century manufacturing data because this approach requires mainly personal interviews with the "experts"-- engineers and managers in the firms. Secondly, the survivor technique developed by Stigler (1958) relies on actual trends in plant sizes over time. The main idea of the survivor technique is that competitive pressures in the long run make only the efficient firms survive. If plants in the size range of x are

³⁹ F. M. Scherer, Industrial Market Structure and Economic Performance (Chicago: Rand McNally College Pub. Co., 1980), pp. 78-80.

surviving or increasing their share of industry output, then they must be efficient and of the optimum plant size. This technique has long been criticized by some economists. Shepherd, for example, makes the criticism that survivor estimates are likely to be more valid for atomistic industries than for highly-concentrated ones.⁴⁰ In view of the criticism, the survivor technique is not a good method for this study covering the period from 1905 to 1915.⁴¹

Another method that has been used to determine scale economies is the relative minimum efficient scale developed by Comanor and Wilson and modified by Caves et al. A proxy of minimum efficient scale (MES) that Caves et al. suggested is that $X=MES$ if CDR exceeds 0.90; zero otherwise. MES is defined as "average employment in the largest establishments accounting for 50 percent of employment in the industry," and CDR is the cost disadvantage ratio, calculated as "the ratio of the average value added per employee in the smallest establishments accounting for 50 percent of the industry value added to the average

⁴⁰William. A. Shepherd, "What Does the Survivor Technique Show about Economies of Scale," Southern Economic Journal 34 (July 1968): 113-122. Shepherd, for example, makes the criticism that survivor estimates are likely to be more valid for atomistic industries than for highly- concentrated ones.

⁴¹Jeremy Attack, "Industrial Structure and the Emergence of the Modern Industrial Corporation," Explorations in Economic History 22 (January 1985): 36-37. Those criticisms may not be so serious before the turn of the century when concentrated industries appeared. Attack measured technical changes in manufacturing industries during 1870-1900 using the survivor technique.

value added per employee in the largest establishments."⁴²

Comanor and Wilson measure MES by "average plant size among the largest plants accounting for 50 percent of industry value of products." This average plant size is divided by value of products in the relevant industry to obtain the scale economies variable used in the regression analysis. Comanor and Wilson found support for this proxy with a high correlation (0.89) between their measures and Bain's direct estimates of MES in the industries common to their two studies, because Bain's estimates can be considered a benchmark against which to appraise various methods of estimating the extent of scale.⁴³ The Comanor-Wilson method will be used in the succeeding analysis.

Capital Requirements (K)

Capital requirements are defined as the cost of fixed capital required to establish a plant of minimum efficient scale. These fixed costs generally are for expensive machines necessary in the production process. It is often argued that certain industries require a large initial capital investment and that the existing firms already in the industry can make above-competitive profits in the long run because

⁴²Richard E. Caves et al., "Social Economies in Statistical Analysis of Market Power," Review of Economics and Statistics 57 (May 1975):135-137.

⁴³W.S. Comanor and T.A. Wilson, "Advertising, Market Structure and Performance," Review of Economics and Statistics 49 (November 1967):287. Comanor and Wilson also reported that the correlation between estimates based on the survival technique and Bain's estimates is 0.66. They concluded that their method is more consistent with Bain's estimates than those computed from the survival technique.

large capital requirements discourage entry of new firms.

However, Stigler defines a barrier to entry as a cost differential applying to firms outside the industry. He claims that capital requirements are therefore not a barrier to entry, since existing firms had to meet those requirements. It is still debatable whether capital requirements cause a barrier to entry.⁴⁴ But many empirical studies which considered capital requirements as independent variables to determine profit rates showed a positive correlation between the size of minimum capital requirements and industry profit rates.⁴⁵

Capital requirements can be measured as follows. MES is the percentage of industry output of a plant of minimally-effective size. Assuming plants of various sizes in the same industry have the same capital output ratio, MES may also be considered to be the percentage of the industry's fixed capital, accounted for by the minimum efficient scale plant. Multiplication of MES by industry fixed capital then yields the capital requirements of the minimum efficient scale.

Multiplant Economies of Scale (MP)

Most mergers result in multiplant operations. That entry may be deterred by multiplant economies has been found by Scherer et al. (1975) and supported empirically by Deutch (1984). These multiplant economies

⁴⁴Harold Demsetz, "Barriers to Entry," American Economic Review 72 (March 1982):47-48.

⁴⁵Bain (1956), Comanor and Wilson (1967), Hall and Weiss (1967), Shepherd (1972), Deutsch (1984), and Caves et al. (1984).

come from technical or pecuniary advantages of the multiplant firms over single plant firms in pooling of risk among plants, obtaining and managing funds, supporting research and development, and engaging in sales promotion activities. Therefore, entrants must enter as multiplant firms to avoid such a cost disadvantage. In this case, capital requirements are increased. Even though entrants into one segment of such an industry would not suffer from a cost disadvantage, they naturally fear that incumbents would be willing to reduce their price-cost margin temporarily in that segment in order to prevent entry. Potential entrants' expected profits will be reduced, and entry likely will be prevented. One estimate of the extent of multiplant operation is obtained by subtracting the total number of firms from the total number of plants in the industry and by dividing the difference by the total number of firms.⁴⁶

Product Differentiation (PD)

Promotion expenditures have been claimed to be entry barriers, since Bain found advertising to be the most important source of product differentiation. (Commanor and Wilson(1967), Michael E. Porter(1974), M. Spence(1980)). With the absolute cost advantage, incumbents set a price above the competitive price, preventing new entry. Comanor and Wilson showed how product differentiation affects the height of barriers, using the advertising expenditure as the proxy for product differentiation

⁴⁶ Larry L. Deutsch, "Entry and Extent of Multiplant Operation," Journal of Industrial Economics 32 (June 1984):482-483.

In their model, product differentiations can generate an absolute cost disadvantage for entrants because of penetration cost, and with an increase in fixed-cost minimum efficient scales will become greater. In addition, entrants might face a difficulty in capital requirement.⁴⁷

Product differentiation, through the establishment of name brands, also is said to lead to barrier to entry. Even after doing the necessary research and development to establish a new product, potential entrants must convince consumers that their product is as good as or better than existing brand name products. Then the newcomer has to spend more on advertising and sales promotion than existing firms, causing the newcomer's average selling cost per unit sold to be higher than the existing firm's.

The magnitude of product differentiation is usually measured in terms of advertising sales ratio. Many studies have related advertising expenditure to profit rates. But the information about this ratio is not available for the early 1900's before the development of the mass media. And advertising is not the only source of the product differentiation barrier. Thus, informed qualitative assessment may be the best that one can do. John Moody in his The Truth About the Trust (1904) compiled information (brand names, trade marks) on the product differentiation that might affect the performance of the consolidated firms. Based on the information, a dummy variable is used to represent

⁴⁷Comanor and Wilson, "Advertising, Market Structure, and Performance," pp.423-40.

product differentiation. If a consolidated firm's product had brand names or trademarks, it is assumed that a consolidated firm engaged in product differentiation strategy might discourage entry of new firms.

Preemptive Patents (PAT)

According to preemptive strategy, the existing firm takes advantage of its current presence in the market to remove the profitable opportunities available to potential rivals. Thus the existing firm may preempt a research opportunity and engage in R & D at a sufficiently fast pace that it does not pay any rival to enter.⁴⁸ Several measures of the preemptive patents have been suggested: R & D expenditure, number of engineers, number of patents, etc. These measures have their own weaknesses, and data are not available for the early 20th century except for patent protection.

The possession of patent rights is significant to barriers to entry and has accounted for high and steady profits. Following the suggestion of Caves et al., a dummy variable of patent strategy will be used. PAT=1 if consolidated firms have some degree of patent protection; PAT=0 otherwise.⁴⁹

Growth Rate of Industry (GR)

There are two theories concerning the influence of growth of market

⁴⁸R. Gilbert and D. Newbery, "Preemptive Patenting and Persistence of Monopoly," American Economic Review 72 (June 1982):514-26.

⁴⁹Caves et al., "The Decline of Dominant Firms," Quarterly Journal of Economics 99 (August 1984):536

demand on profit rates. Bain and Caves argue that the rate of growth of industry demand may be a useful measure of the incentive to enter, since an expanding market implies that collusive agreements are harder to maintain, and an entrants' supply will not depress industry price. A rapid growth rate of industry is expected to lower barriers to entry. A second argument (Hall and Weiss, 1967) is that industry growth is likely to positively associate with profitability because of errors in demand expectations and a lag in supply response. Many empirical studies (Comanor and Wilson (1967), Shepherd (1972) and Porter (1974)) found a positive relationship between industry growth rate and profit rates. Growth in industry output is used here to measure growth in demand. The growth rate of industry output is measured by the ratio of 1915 industry shipments to 1905 industry shipments.

Tariff Protection (TA)

It is argued that tariff protection was important for increasing the initial earning power of many consolidated firms.⁵⁰ The tariff protection seems to have been the significant factor for the consolidated firms' performance, even though opinions differ as to the extent of the opportunity for consolidated firms' performance created by tariff legislation since 1890 and especially by the Tariff Act of 1897.

The American Sugar Refining Company is an example of consolidated firms that benefited from tariffs. Its profits had been large and its

⁵⁰ Charles Beardsley, "The Tariff and the Trusts," Quarterly Journal of Economics 15 (May 1901):371-89.

prices high, but the tariff on refined sugar was almost prohibitory (ad valorem rate of 71.23 percent). Another strong consolidation which has earned very large profits for a number of years, under favor of tariff legislation, was the American Tobacco Company. This company was making an average profit of 11.28 percent during 1905-1915. The tariff on cigarettes and paper cigars, which are main products of the company, is the ad valorem rate of 143.73 percent. The tariff is several times the wholesale, or even the retail, price of the more popular grades of cigarettes.

A dummy variable is used to represent tariff protection of consolidated firms. $TA = 1$ if the consolidated firms' product line received substantial tariff protection around 1905; $TA = 0$, otherwise.

Initial Market Share (IMS)

The other variable to be considered is market share. In recent years, empirical researchers have paid increasing attention to individual firm's market shares as possible determinants of both industry profitability and individual firm profitability. It is difficult for researchers to estimate market shares for individual firms within given industries because of the market definition and the multiproduct problem. In the early 1900's, the specific market share of consolidated firms was not available. Alternatively, following the Livermore classification, consolidated firms are divided into two groups--those in one group have "power enough to influence markedly conditions in their industry," and those in the other group do not. A dummy variable to reflect market control power is used in the model.

Estimation Procedure

When profit rates are used as the dependent variable, there is a problem that we cannot observe the profit rates of those firms which were out of business or were in receivership; we can only measure profit rates of those firms which maintained their existence. Thus, the dependent variable in the estimation of consolidated firms' performance in terms of profitability is limited to positive values.

Usual regression procedures suffer from some drawbacks when the dependent variable in a model can have only a limited range of values. As clearly stated in most standard econometric textbooks, due to the special nature of limited dependent variables in an ordinary regression equation, the classical assumptions of the error term such as zero mean, homoscedasticity, and normality are no longer valid. The ordinary least squares estimators of the coefficients are no longer efficient when disturbance terms are heteroscedastic. Without the normality assumption, the classical tests of significance cannot be applied and the goodness-of-fit test has only limited validity.⁵¹ Therefore, the ordinary regression analysis would be an inappropriate technique to apply to the problems with limited dependent variables, such as the consolidated firms' performance in this study.

With the limitations of dependent variables, other estimation procedures more suitable for the study are needed. Two approaches--

⁵¹George G. Judge et al., The Theory and Practice of Econometrics, 2nd edition, (New York: John Wiley and Sons, Inc., 1985), pp.752-783.

probit and Tobit models--seem to offer more promising alternatives. A probit regression is used to examine the relationship between the dichotomous dependent variable (whether or not consolidated firms were successful) and the independent variables to determine consolidated firms' performance. There is not a clear-cut criterion to make the line between success and failure. The problem here is where success and failure are divided on the spectrum of profit rates. It is, however, obvious that when consolidated firms disappeared, had a deficit over time, were in receivership, or were reorganized they should be classified as a 'failure' and those firms making positive profits are classified as a 'success.'⁵² When a probit regression is used, the value of dependent variable (R) equals zero if the firms are classified as failure and equals one if the firms were successful.⁵³

When the probability of success of the consolidated firms is the only variable of interest, the probit model would be sufficient. But

⁵²Livermore, "The Success of Industrial Mergers," Quarterly Journal of Economics 50 (November 1935):92-95. Livermore classified his collected firms into success, failure and two intermediate groups (limping and rejuvenation). He did this by studying earnings on capitalization in a survey of the dividends records and company histories. Most of the failure group was easily classified because they had terminated their existence and were in receivership or had been reorganized. But in the case of the successful companies and intermediate groups, Livermore did not give any specific average earning rate for his classification.

⁵³G.S. Maddala, Econometrics (New York: McGraw-Hill, 1977), pp. 132-141. Qualitative facts, for which no cardinal or ordinal numerical measures exist, are expressed in numerical terms by use of appropriate dummy variables. The dummy variable customarily assumes a value of zero or one--one usually referring to the occurrence of an event or the presence of a characteristic and zero referring to the non-occurrence of the event or the absence of the characteristic.

using the probit model, Tobin points out, would be inefficient, since information on the magnitude of the dependent variable (in this case, profit rate of successful firms) is available.⁵⁴ Given a large concentration of observations at the zero profit rate,⁵⁵ ordinary multiple regression analysis would not be appropriate. Because of the special nature of dependent variables, there are heteroscedasticity problems of the disturbance term so that the ordinary least squares estimators, although unbiased, are not efficient. The Tobit technique (Tobin's probit) permits us to use all observations, both those at the limit and those above it, to estimate a regression line. The Tobit model, which combines the properties of the probit and multiple regression model, is therefore more appropriate for estimation of the model.

The Tobit regression model to estimate the relative importance of various determinants of consolidated firms' performance may be specified as follows:

$$R_j = \beta_0 + \beta_1 \text{VIS}_j + \beta_2 \text{MES}_j + \beta_3 \text{K}_j + \beta_4 \text{MP}_j + \beta_5 \text{IMS}_j + \beta_6 \text{PD}_j \\ + \beta_7 \text{PAT}_j + \beta_8 \text{TA}_j + \beta_9 \text{GR}_j + U_j, \quad \text{when } R_j > 0$$

$$= 0$$

$$\text{when } R_j = 0$$

where $j = 1, \dots, n$

⁵⁴J. Tobin, "Estimation of Relationships for Limited Dependent Variables," Econometrica 26 (January 1958):24-36.

⁵⁵The profit rates of failed firm are assumed to be zero.

R : Profit rate of each consolidated firm
 VIS : Degree of vertical integration of industry
 MES : Minimum efficient scale representing economies of scale
 K : Capital requirements
 MP : Multiplant plant economies
 IMS : Dummy variable reflecting initial market share
 PD : Dummy variable reflecting product differentiation strategy
 PAT : Dummy variable reflecting preemptive patents strategy
 GR : Industry growth rate
 TA : Dummy variable reflecting tariff protection

Rewriting the above equation using matrix notation,

$$\begin{aligned}
 R_j &= X_j \beta + U_j && \text{if } R_j > 0 \\
 &= 0 && \text{otherwise, } j = 1, \dots, n
 \end{aligned}$$

where n is the number of observations. R_j is the dependent variable, X_j is a matrix of independent variables, β is a vector of unknown coefficients, and U_j is an independently distributed error term assumed to be normal, with zero mean and constant variance.

Tobin suggested the maximum likelihood method to estimate the unknown coefficients (β). The subject of the maximum likelihood estimation was further studied by Amemiya.⁵⁶ He proved that the Tobit

⁵⁶T. Amemiya, "Regression Analysis When the Dependent Variable is Truncated Normal," Econometrica 41 (November 1973):997-1016.

maximum likelihood estimator is strongly consistent and asymptotically normal.

Following Amemiya, the likelihood function is defined as

$$L = \prod_s [1 - F (X_j \beta, \sigma^2)] \prod_r f (R - X_j \beta, \sigma^2)$$

where given n independent observations, s observations record a zero value for the dependent variable, and $r = n - s$ observations record a positive value.

$$\text{And } F_j (X \beta, \sigma^2) = \int_{-\infty}^{X\beta} f (Z, \sigma^2) dz$$

$$f_j (Z, \sigma^2) = \frac{1}{\sqrt{2\pi} \sigma} e^{-z/2\sigma}$$

where $F_j (.)$ and $f_j (.)$ are the cumulative distribution function and probability density function of a $N (0, \sigma^2)$ random variable, respectively. We can write the log likelihood function as

$$\log L = \sum_s \log (1 - F_j) - \frac{R_j}{2} \log \sigma^2 - \sum_r \frac{1}{2\sigma^2} (R_j - X_j \beta)^2$$

The first order conditions for maximizing the $\log L$ with respect to β and σ^2 are

$$\frac{d \log L}{d \beta} = 0, \quad \frac{d \log L}{d \sigma^2} = 0$$

From the above equations, σ^2 can be obtained as a function of β . Those equations are nonlinear in parameters and hence must be solved

iteratively. Given σ^2 , the Newton-Raphson method can be applied to find the unknown coefficient β .

Data and Data Sources

The data used in this study include the 1905-1915 period and were derived from the following sources: Moody's Manuals (1905-1915), The Truth About the Trusts (1904), and The Census of Manufactures (1905, 1915).⁵⁷ Moody published his Truth About the Trusts (1904) as a study on results of the first merger movement. Since then, it has been generally accepted as a primary source even though there have been criticisms.⁵⁸ According to Moody, 318 industrial mergers formed prior to 1904 involving over \$7 billion in securities issues and 5,288 independent manufacturing plants disappeared by merger between 1880 and 1904.⁵⁹ For the 318 mergers, Moody examined 92 large mergers in more detail and provided information on their competitive advantages--patents, trademarks, raw-material supplies, tariffs, and market shares that may have affected the financial performance of the combinations.

⁵⁷The data were not extended beyond 1915 to avoid the potential distortions caused by World War I.

⁵⁸Jesse W. Markham, "Survey of the Evidence and Finding on Mergers," Business Concentration and Public Policy, pp.158-162. Universities- National Bureau Committee for Economic Research Conference, (Princeton: Princeton University Press 1955). Moody's sources seemed to be based on current financial journals, especially Commercial and Financial Chronicle.

⁵⁹Moody, The Truth About the Trust (New York: Moody Publishing Co., 1904), pp.486-487.

Livermore noted that Moody included a large number of concerns only by "a fantastic stretching of the terms." Livermore included in his study only mergers that gave rise to firms with sufficient power to influence their respective markets. He omitted mergers that at the outset could clearly be recognized as non-monopolistic, while Moody's list includes all mergers that had over \$1 million in capital.

Another criticism of Moody's data is concerned with percentage of the market share which Moody calculated for 92 consolidated firms. The percentage of the market share which Moody estimated seems not to be reliable for this study because classification by industry was not undertaken. Lamoreaux pointed out that Moody's own sources relied heavily on the statements of promoters, and Moody's estimates were exaggerated. Lamoreaux checked Moody's findings against other sources whenever possible (mainly secondary sources) by classifying market share into three broad numerical categories: below 40%, between 40% and 70%, and above 70%.⁶⁰ Lamoreaux did this without defining the extent of market either. In spite of the criticisms, Moody's data have been recognized as the primary source of information. In this study, the percentage of market share reported by Moody is not used because Moody's implicit definition of industry is different from the size of industry which is defined by the Census of Manufactures; the alternative way is to use Livermore's classification through dummy variable.

With consideration to Livermore's criticism of Moody's list,

⁶⁰ Lamoreaux, The Great Merger Movement (New York: Cambridge University Press, 1985), pp. 2-4.

consolidated firms for this study were based on Moody's. Thirteen mergers from the Moody list were eliminated because they were formed prior to 1887--the beginning year of the first merger movement--or were foreign corporations. Thirty-eight mergers were dropped from the list because they were local and so small that they obviously obtained no greater market influence through consolidations. Thus this study starts with 267 consolidated firms which were formed between 1887 and 1904. Firms for which incomplete information made classification by success and failure impossible were eliminated. Non-manufacturing firms and those for which there is no information about products were also dropped. The approximate number of observations for each model is given in Table III-1.

Table III-1: Number of Consolidated Firms for Probit and Tobit Regression Model

Probit Model		Tobit Model	
Successful Firms	135	Successful Firms	82
Failed Firm	93	Failed Firms	93
Total	228	Total	175

Source: John Moody, The Truth About the Trust (New York: Moody Publishing Co., 1904) and Moody's Manuals of Industrial Securities, 1905-1915.

The reason for differences in numbers of successful firms in both models is that even though consolidated firms were successful, their profit rates were not reported; thus, these firms were eliminated in the Tobit regression model.

The Census of Manufactures (1905) provides necessary data to measure industry variables. Most studies of hypotheses concerning industry

structure use data organized by the Standard Industrial Classification (SIC) system. According to the system, a single code is assigned to the output of every business enterprise. The 4-digit SIC code of 1967 is used for each industry because SIC codes were not given to the Census of Manufactures in 1905.

The consolidated firms are classified into four-digit groups in the standard industrial classification of 1967. Data on structural variables are collected at the industry level from the Census of Manufactures, and data on firms' strategic variables at the firm level are collected from Moody's Manuals and Truth About the Trust. Thus, the empirical model contains firm data and industry data in the same equation. The underlying rationale for combining firm and industry data is that the firm's performance is influenced by structural industry characteristics. For example, as Caves and Porter discussed, barriers to entry are a collective capital good for the firms in the industry. If one firm in an industry erects entry barriers, its behavior also has side effects on other firms in the same industry. All firms in the industry can be protected by industry barriers to entry.⁶¹

On the empirical side, Hall and Weiss pioneered the inclusion of firm and industry data in the same equation.⁶² Since then this method has been commonly used. For example, Shepherd (1972) regressed firm's

⁶¹Caves and Porter, "From Entry Barriers to Mobility Barriers," Quarterly Journal of Economics 91 (May 1977):247-248.

⁶²M. Hall and L.W. Weiss, "Firm Size and Profitability," Review of Economics and Statistics 49 (August 1967):319-331.

profitability on the structural variables measured at industry level and on firm level variables.⁶³ In this study, we use industry data for degree of vertical integration, capital requirements, minimum efficient scale, multiplant economies of scale, and industry growth rate. For profit rate, firms' strategic variables, and initial market share, firm data will be used.

⁶³W. A. Shepherd, "The Elements of Market Structure," Review of Economics and Statistics 54 (February 1972):25-37. For Shepherd's empirical model (1972), firms' profits = f (firms' market share, barriers to entry of industry, growth rate, etc.). Also for Caves et al.'s empirical model (1984), firms' profits = f (economies of scale, capital cost requirements, growth rates, firms' level vertical integration, patents, etc.).

CHAPTER IV

EMPIRICAL RESULTS

The results of estimating the probit and Tobit regression models through maximum likelihood procedures are reported and discussed in this chapter. Before an examination of the regression results, the basic econometric problems of regression analysis need to be discussed.

Preliminary results of the regression indicated that multicollinearity and autocorrelation were not serious problems. Multicollinearity is one of the most common problems encountered when using econometric methods. A high degree of correlation among independent variables could result in estimated coefficients which are highly imprecise.⁶⁴ This implies that some variables could be considered statistically nonsignificant, when in fact they are significant.

A correlation matrix using the independent variables included in the regression equation was calculated to estimate the degree of multicollinearity present. Results of those calculations are presented in Table IV-1. This table shows that a high degree of multicollinearity did not exist among the independent variables. Although the correlation coefficient between VIS and K was -0.43, a small level of collinearity is common in regression analysis and is not a serious problem.

Another statistical problem generally encountered with time series

⁶⁴J. Johnston, Econometric Methods, 3rd edition, (New York: McGraw-Hill, 1984), pp.245-246.

Table IV-1: Simple Correlation Coefficients
Among Independent Variables, N=228

	MES	VIS	K	GR	IMS	PAT	PD	TA
MES	1.0							
VIS	-0.25*	1.0						
K	0.25*	-0.43*	1.0					
GR	0.03	0.08	-0.17*	1.0				
IMS	0.01*	0.02	-0.02	-0.09	1.0			
PAT	0.01	0.15*	0.07	-0.01	0.22*	1.0		
PD	0.04	0.04	-0.07	0.04	0.15*	0.13	1.0	
TA	0.10	0.01	0.01	-0.07	0.25*	0.15*	0.28*	1.0

* Denotes 5 percent level of significance.

data is serial correlation among error terms, which is known as autocorrelation. Autocorrelation tends to bias the estimates of the standard errors of the regression coefficients. Due to the use of cross-sectional data in this study, autocorrelation was not expected to be a problem.

A common statistical test to determine whether autocorrelation is present is calculation of the Durbin-Watson (d) statistic. This statistic can be used to test for either positive or negative first-order autocorrelation. Estimations of the probit and Tobit model revealed a Durbin-Watson statistic in the range of 1.97 to 2.13 (see pages 61 and 65). Thus, the hypothesis of no first-order autocorrelation of residuals was thus accepted at the 0.01 confidence level as expected.

The correlations of dependent variables (SF, PRF) with each explanatory variable are presented in Table IV-2. The correlations between SF and MES (0.17), PAT (0.13), PD (0.22), TA (0.21) and IMS (0.13) all take the expected sign and differ significantly from zero at the one percent level of confidence. The correlations between SF and VIS (0.02), K (0.10), GR (0.02) do not prove to be significant. Correlations with PRF are generally consistent with our expectations. Economies of scale (MES), capital requirements (K), initial market share (IMS), patents (PAT), product differentiation (PD), and tariffs (TA) are all signed as expected and significant at the .05 level. Weaker correlation appears between GR and PRF (10 percent level of significance). Correlation between VIS and PRF (-0.01) proves to be insignificant with the wrong sign. Table IV-2 indicates that the IMS

Table IV-2: Simple Correlation Coefficients Between
Dependent Variable (PRF, SF) and
Various Independent Variables

	SF	PRF
MES	0.17 ^{**}	0.21 ^{**}
VIS	0.02	-0.01
K	0.10	0.17 ^{**}
GR	0.02	0.04 [*]
PAT	0.13 ^{**}	0.28 ^{**}
PD	0.22 ^{**}	0.29 ^{**}
TA	0.21 ^{**}	0.29 ^{**}
IMS	0.13 ^{**}	0.37 ^{***}
SF	1.00	0.92 ^{***}
	N=228	N=175

* indicates coefficient is statistically significant at
the 90 percent level

** at the 95 percent level

*** at the 99 percent level

Tests of significance are made on the basis of two-tail t tests.

variable especially is highly correlated with PRF at the .05 level. From the high correlation (0.37) we expect that initial market share would significantly influence the consolidated firms' performance.

Examination of the dependent variable in Table IV-2 indicates that the dependent variable (SF) in the probit model was shown to be very highly correlated with the dependent variable (PRF) in the Tobit model with a coefficient of 0.92 at the 0.01 significance level. This implies that they are stable as dependent variables. The correlation coefficients between explanatory variables and PRF is generally higher than those between each explanatory variable and SF except for the VIS variable. This also implies that the Tobit regression would fit to the model explaining consolidated firms' performance better than the probit's.

Interpretations of Empirical Results ⁶⁵

The estimated coefficients in a Tobit model must be interpreted with care. MacDonald and Moffitt (1980) explore the interpretation and use of the estimated Tobit coefficients. Specifically, the change in a firm's profit rate (PRF) associated with a change in a given independent variable, X_i , is

⁶⁵To estimate the probit and Tobit regression models we used Kenneth J. White's statistical package, Shazam: An Econometrics Computer Program, version 4.6, (Vancouver: University of British Columbia, 1984).

$$\beta_i = \frac{d \text{ PRF}}{d X_i} = F(z) \cdot \frac{d E(\text{PRF})}{d X_i} + E(\text{PRF}) \cdot \frac{d F(z)}{d X_i}$$

where $z = X_i \beta / \sigma^2$ (the Tobit index), $F(z)$ is the cumulative standard normal distribution function, and $E(\text{PRF})$ is the expected value of the dependent variable PRF given that $\text{PRF} > 0$.

Thus, the total change in PRF associated with a change in an independent variable can be disaggregated into two parts: first, the change in PRF for those above the limit (positive profit rates) weighted by the probability of being above the limit ($\text{PRF} > 0$) and second, the change in probability of having $\text{PRF} > 0$ weighted by the expected value of PRF given that $\text{PRF} > 0$.

These values, of course, depend upon the parameters β and σ^2 , as well as the values of the independent variables X_i . Interpretation of regression coefficients in the Tobit procedure is somewhat complicated because the estimated coefficients are not equal to the magnitude of the change in PRF associated with an incremental change in any independent variable.

Instead, the total effect on PRF from an incremental change in one of the independent variables is given by $F(z) \cdot \beta_i$ where β_i is the regression coefficient for the i th independent variable. When evaluated at the mean values for the independent variables, $F(z) = 0.437$, which indicates that the total effect of a change in an independent variable on PRF is given by 43.7 percent of the coefficient reported in Table IV-3.

Table IV-3: Tobit and Probit Regression Results

Independent Variables	Tobit Model		Probit Model	
	Coefficient	T-Ratio	Coefficient	T-Ratio
VIS	0.23	-0.39	0.26	0.46
MES	9.74	3.74***	8.70	2.94***
K	0.14	0.93	0.08	0.52
IMS	0.87	3.86***	-0.16	-0.93
PD	0.77	2.96***	0.93	2.66**
PAT	0.53	2.16**	0.08	0.45
GR	-0.11	-0.56	0.38	1.38
TA	0.11	0.58	0.73	2.22**
CONSTANT	-1.15	-3.43***	-0.41	-1.36

d.w.: 2.13, R^2 : 0.26

d.w: 1.97, R^2 : 0.13

Tobit analysis, limit = 0
93 Limit observations
82 Non-limit observations.

228 Total observations
135 Observations at 1
93 Observations at 0

** 5 percent level of significance.
*** 1 percent

For the Tobit and probit model, eight independent variables⁶⁶ were regressed on dependent variable (PRF) which represents zero or positive profit rate of consolidated firms and on the dummy dependent variable (SF) reflecting a firm's success and failure. The calculated coefficients and other statistics are presented in Table IV-3.

The coefficients on the degree of vertical integration of industry (VIS) proved to be insignificant in both models with the positive sign in the probit and the negative sign in the Tobit. This suggests that vertical integration neither provided a basis for superior efficiency or as a source of barriers to entry. Alternatively, the insignificance of VIS might reflect imprecision in the measurement of vertical integration as previously noted. The estimation also indicates that economies of scale (MES) was a positive and significant determinant of consolidated firms' performance as t-values indicate the one percent level of significance in both Tobit and probit models. This indicates that the ability of consolidated firms to avail themselves of economies of scale proved to be a valuable determinant of their ultimate success.

The variable PD (Product differentiation) is also highly significant at the .01 level of significance in both models with expected signs. The significance of the PD variable indicates that consolidated firms engaged in a strategy of product differentiation tended to be successful and obtained significantly higher profit rates.

⁶⁶The multiplant variable (MP) was deleted in the probit and Tobit model because the proxy was not reliable. The number of plants as a proxy of MP was regressed but proved to be insignificant. The statistical result was not improved.

In addition, this finding confirms many previous findings that product differentiation leads to entry barriers and then to profitability.

The negative sign of the coefficient of the industry growth rate (GR) variable in the Tobit model was consistent with the Bain and Caves argument. That is, a high growth rate in an industry is expected to lower barriers to entry and then to reduce profit rates. The calculated t-values in both models, however, were not statistically significant at the .05 level of significance. The GR variable proved to be an insignificant factor in affecting a consolidated firm's performance.

The capital requirements variable (K) had a positive sign on the coefficients, and the calculated t-ratio was not statistically significant in either model. This insignificance is interpreted as follows. First, capital requirements cannot present a barrier to entry as Stigler argued. Secondly, the variable k was highly correlated with the variable VIS (the coefficient is -0.43 at the .05 level), so that the estimated coefficients might not be correct. This factor was not a significant determinant for the performance of consolidated firms during 1905-1915.

The three variables, PAT (patents), TA (tariffs), and IMS (initial market share) seemed very sensitive to the model specification. In the probit model, TA was significant at .05 level, and PAT and IMS were not significant. On the other hand, in the Tobit model, IMS and PAT were significant with expected signs at the .01 and .05 levels while TA was not. However, as Tobin points out, the Tobit model uses given

information more efficiently than the probit model.⁶⁷ The overall explanatory power of the model, that is, the weighted R^2 (0.26) of the Tobit model, was greater than R^2 of the probit (0.13) (Table IV-3). Thus the Tobit model, which combines the properties of the probit and multiple regression model seems more appropriate for estimation of the model.

Assuming that the Tobit results are more appropriate, the significance of IMS ($t=3.86$) indicates that when firms' consolidation resulted in a large market share, their success was highly probable. This results in an interesting interpretation. The result is counter to Livermore's findings that the market control variable did not affect consolidated firms' successes or failures. As mentioned previously, Livermore divided consolidated firms into two main groups; first, those which influence the market, and second, those which did not. He found that the number of success and failure firms are the same in both groups. Thus, he concluded that the market share variable was not an important determinant for firms' success or failure.

For comparison purposes, estimates by the ordinary least squares (OLS) method are presented in Table IV-4. Those results are not different from the Tobit model's. Economies of scale (MES), product differentiation (PD), patents (PAT) and initial market share (IMS) are still significant.

⁶⁷Tobin, "Estimation of Relationships for Limited Dependent Variables," Econometrica 26 (January 1958):25.

Table IV-4: OLS Regression Results,
Dependent Variable, PRF

Independent Variables	Coefficients	T-ratios
VIS	0.03	-0.41
MES	0.29	4.07***
K	0.05	0.70
GR	0.05	0.75
IMS	0.22	3.02***
PD	1.20	2.83***
PAT	0.16	2.16**
TA	0.03	0.47
CONSTANT	0.03	0.26
F-ratio: 6.7		
d.w.: 2.09 R^2 : 0.21		

Observations: 175

** 5 percent level of significance.

*** 1 percent

CHAPTER V

SUMMARY AND CONCLUSION

This study has developed a model that can be used to examine which factors might have affected consolidated firms' performance during 1905-1915. The study is different from studies of other periods in several respects. First, most studies of structure-conduct-performance have used industry profit rates as a measure of industry performance.⁶⁸ This study uses consolidated firms' profit rate as a method of measuring consolidated firms' performance. The profit rate of consolidated firms was calculated from the Moody's Manuals (1905-1915). Second, most studies of structure-conduct-performance have been concerned with only successful (existing) firms. The observation for this study, however, includes both firms that succeeded in consolidations and those that failed. To account for the inclusion of failed firms, probit and Tobit regression models were constructed for the estimation of the relationship between consolidated firms' performance and their determinants.

Third, more entry-deterring variables expected to influence consolidated firms' performances were included and tested in the model. There are basically two general methods of measuring entry barriers.

⁶⁸For example, see Bain (1951), Mann (1966), Comanor and Wilson (1967), M. Porter (1974), and Deutsch (1984).

The first method was developed by Bain.⁶⁹ For each industry, Bain assessed the height of barriers to entry on the basis of knowledge of his own primary and secondary sources concerning scale economies, product differentiation, absolute costs, and capital requirements. An overall barrier into each industry was described as 'very high,' 'substantial,' or 'moderate-to-low.' Thus this approach is, to a large degree, qualitative in its assignment of the height of entry barriers. The other method, developed by Comanor and Wilson, was to choose proxies for barriers to entry (e.g., for economies of scale, the proxy is minimum efficient scale).⁷⁰ These quantitative proxies are then included in a multiple regression of industry performance. My study used both qualitative and quantitative measures at the same time. Structural barriers to entry were measured quantitatively using Census of Manufactures (1905). Artificial barriers to entry caused by a firm's strategic behavior were evaluated qualitatively using Moody's Truth About the Trust (1904). The study has included a variety of entry-detering variables in the regression model that have previously not been included in studies of firm performance during the period of 1905-1915. For example, vertical integration of industry (VIS), patent strategy (PAT), and tariff protection (TA) are all included in the model. The advantage of including several factors separately into the

⁶⁹ Bain, Barriers to New Competition (Cambridge: Harvard University Press, 1958), pp.167-181.

⁷⁰ Comanor and Wilson, "Advertising, Market Structure and Performance," Review of Economics and Statistics 49 (November 1967):423-440.

model is that we can evaluate the effect of each factor on consolidated firms' performance.

The study also differs in that it has used data dealing with 228 firms in the probit model, 175 firms in the Tobit model, and 89 manufacturing industries. This is more than that used in other studies (i.e. Caves et al. (1984) examined 39 firms; Arther Dewing (1921), 35 firms; The National Industrial Conference Board (1929), 48 firms).

While the novel aspects of the model shed significant new light on the determinants of consolidated firm performance, the insights provided are limited by the availability of data. For instance, dichotomous specifications of several variables (i.e. PD, PAT, TA, IMS) were required due to data limitations even though continuous specifications would have been desirable.

The statistical tests point toward a number of conclusions. Economies of scale (MES) and product differentiation (PD) proved to be significant determinants of the consolidated firms' performance. This result seems stable, for MES and PD were significant at a one percent confidence level in all the Tobit, probit, and OLS models. From this, we may conclude that consolidated firms tended to be more successful when the minimum efficient scale of industry in which they were operating was larger.⁷¹ This finding substantially supported Chandler's

⁷¹ Economies of scale not only make a source of barriers to entry but also reflect superior efficiency. The question of whether the consolidated firm's success was attributable to efficiency or to barriers to entry of economies of scale is important for the antitrust policy implication. But the regression analysis could not differentiate
(Footnote Continued)

and Porter's argument, that is, "Big businesses were much more likely to succeed if they were in industries which achieved genuine economies of scale."⁷² Consolidated firms in industries that did not realize economies of scale could not control the potential competition. The appearance of potential competitors was a principal cause of firm failure in the cases of National Cordage and U.S. Leather. The results also indicate that product differentiation (PD) was another major determinant of consolidated firms' performance. This finding also supported the argument of Livermore, Chandler, Porter, and Lamoreaux that product differentiation by advertising and brand names was a strategy for consolidated firms' success. The statistical result regarding product differentiation (PD) is consistent with other empirical findings from previous studies (Comanor-Wilson (1967), Deutsch (1984), and M. Porter (1974)).

The regression results in the previous chapter show that vertical integration (VIS), capital requirements (K), and growth rate (GR) on the level of industry proved to be insignificant determinants of consolidated firms' performance. The insignificance of capital requirements (K) contradicts many previous findings, which showed a positive and significant relationship between capital requirements barrier and profitability (Comanor-Wilson (1967), Caves et al. (1984),

(Footnote Continued)

between efficiency's and barriers' effects of scale economies on the profit rates of consolidated firms.

⁷²Glenn Porter, The Rise of Big Business (New York: Thomas Y. Crowell, 1973), p.81.

and M. Porter (1974)).

The insignificance of capital requirements as a barrier to entry may be attributed to overcapitalization of consolidated firms at the turn of the century. Firms issued capital stock and other securities in excess of the value of the firms' assets. This "overcapitalization" was commonplace during the great merger movement.⁷³ In his study of fourteen large consolidations, Dewing found that on the average actual tangible property without goodwill accounted for only 40 percent of the par value of the total issued securities.⁷⁴ For example, the property acquired by the United States Leather Company had an assessed market value of \$60,000,000 against which the company issued \$131,000,000 of securities. National Cordage Company had the property of estimated value of \$4,000,000 against which \$15,000,000 of securities had been issued.⁷⁵ The percentage excess of securities over assets was 54 percent for United States Leather Company and 73 percent for National Cordage Company. The large capitalization by stock-watering, in fact, does not reflect a large capital requirements barrier to entry. The Census data used in constructing the capital requirements variable may have been affected by overcapitalization that accompanied the consolidations. Capital requirements were measured as follows.

⁷³ Ralph L. Nelson, Merger Movements in American Industry: 1895-1956 (Princeton: Princeton University Press, 1959), p.19.

⁷⁴ Arthur S. Dewing, Corporate Promotions and Reorganizations (Cambridge: Harvard University Press, 1914), p.541.

⁷⁵ ibid., p.20, p.123.

Multiplication of the percentage of industry output of MES (minimum efficient size) by industry assets yields the capital requirements of the plant of MES. Firms were requested to report the value of land, buildings, machinery, etc., as distinct from their capitalization. All the items of fixed and live capital might be taken at the amounts carried on the books.⁷⁶ In the case of overcapitalization, it happens that an arbitrary value is assigned to the assets of the firm in order to balance its securities, and this arbitrary value was likely to be reported to Census Bureau rather than the actual market value.⁷⁷ In view of this the figures for capital did not show the actual amount of the capital invested in manufacturing firms. Given that inflation of the book value of assets was part of the process of trust creation in the period studied it is not surprising that capital requirements do not appear to have been positively correlated with success. Studies of later periods that do show such a relationship presumably reflect more accurately the differences in physical capital requirements.

Patents were expected to be an important means of restricting competition and obtaining high and steady profits by protecting products of consolidated firms.⁷⁸ Tariff protection was also expected to affect profit rates of consolidated firms. But the regression result shows

⁷⁶ Abstract of Census of Manufactures, 1914 (Washington, D.C.: U.S. Government Printing Office, 1917), pp.10-11.

⁷⁷ ibid., p.13.

⁷⁸ Chandler, The Visible Hand (Cambridge: Belknap Press, 1977), pp.374-375.

that patent strategy (PAT) and tariff protection (TA) proved to be unstable determinants due to their sensitivity to the model specification. Patent strategy (PAT) was significant in Tobit and OLS regressions but not in probit. Tariffs (TA) proved to be significant in the probit model but not in Tobit and OLS regressions. Caves et al. (1984) also found PAT and TA to be insignificant variables for dominant firms' profit rates during 1905-1915.

The insignificance of PAT may come from the fact that the growth of systematic research and development to develop new products began in the 1920's.⁷⁹ Before that, R&D for preemptive patents was not developed, and, thus the possession of only patents did not seem to be a good proxy of preemptive patent strategy. One explanation of the insignificance of tariffs (TA) is that some industries, such as steel, cotton, and paper, are largely independent of the tariff. The cost of production of those industries was quite as low in the United States as in foreign countries, owing to the economies of production on a very large scale or to the closer proximity of domestic firms to the sources of supply for the raw material of manufacture as in the case of the cotton manufacture.⁸⁰ Thus the effect of tariff protection on consolidated firms' performance did not seem to be consistent. It has been recognized that some variables such as tariffs and patents, may have

⁷⁹ Alfred D. Chandler., Jr, "The Beginning of 'Big Business' in American Industry," Business History Review 33 (Spring 1959):2.

⁸⁰ Beardsley, "The Tariff and the Trusts," Quarterly Journal of Economics 15 (May 1901):380-382.

been endogeneously determined; that is, those variables themselves can be linked to the market structure. The development of adequate models to explain the simultaneity requires further work.

Generally, the empirical results support the proposition that structural conditions and artificial barriers to entry affected the consolidated firms' performance during 1905-1915. In particular, we may conclude that economies of scale and a strategy of product differentiation were significant determinants of consolidated firms success during 1905-1915.

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APPENDIX

Table A-1: Summary of Independent Variables and Expected Signs for Influence on Dependent Variables

Dependent Variable	Independent Variable	Expected Sign
SF, PRF	VIS	+
	MES	+
	K	+
	MP	+
	IMS	+
	PD	+
	PAT	+
	TA	+
	GR	?

Table A-2: Summary of Independent and Dependent Variables
(Year, Source and Measurement)

Variable	Year	Source*	Measurement
SF: The dependent variable indicating firm's success or failure	1905-1915	B	Dummy variable
PRF: The dependent variable indicating average profit rates	1905-1915	B	Average earning rates
VIS: The degree of vertical integration in structure	1905	A	Ratio of value added to sales
MES: Economies of scale	1905	A	Comanor and Wilson's method
K: Capital requirements	1905	A	Comanor and Wilson's method
PD: Product differentiation	1905	C	Dummy indicating brandnames, trade marks, etc.
PAT: Preemptive patenting	1905	C	Dummy variable indicating control of significant patents
MP: Multiplant operation	1905	A,C	Deutsch's method and number of plant divided by average plant number in industry

Table A-2 (continued)

Variable	Year	Source [*]	Measurement
GR: Growth rate of industry output	1905-1915	A	The ratio of 1915 industry output to 1905 industry output
TA: Substantial tariff protection	1905	C	Dummy variable
IMS: Initial market share	1905	C , D	Dummy variable indicating market power

*

A : Census of Manufactures, 1905

B : Moody's Manuals of Industrial Securities, 1905-1915

C : Moody's The Truth About The Trusts (1904)

D : Livermore's classification

Table A-3: Industry Data on Economies of Scale (MES), Growth Rate (GR),
Vertical Integration (VIS) and Capital Requirements (K)
Around 1905

	SIC*	MES	GR	VIS	K
<u>Industry</u>					
Butter	2021	0.00042	0.1054	0.1454	30080
Condensed Milk	2023	0.01717	0.0654	0.2023	10943
Canned, Fish	2031	0.00819	0.0669	0.2389	9577
Canning & Preserving	2033	0.00321	0.0909	0.3400	47629
Flours & Grist Mill	2041	0.00076	0.0231	0.1305	265117
Food Preservation	2043	0.01560	0.2585	0.3840	51784
Glucose & Starch	2046	0.02040	0.0612	0.2184	24053
Bread & Bakery	2050	0.00033	0.0825	0.4241	122363
Sugar Refining	2062	0.06424	0.0047	0.1170	165468
Beet Sugar	2063	0.03130	0.1566	0.4060	55923
Confectionary	2070	0.00345	0.0962	0.4395	43125
Liquors, Malt	2082	0.00191	0.0482	0.7489	515630
Malt	2083	0.01351	0.0589	0.2202	47934
Liquors, Distilled	2085	0.03130	0.0575	0.8050	50101
Oil, Cotton Seed	2091	0.00340	0.1200	0.1699	73770
Grease & Tallow	2094	0.01691	0.0324	0.3426	10284
Ice Manufactured	2097	0.00395	0.1538	0.7473	66592
Baking & Yeast	2098	0.10465	0.0171	0.5306	13233
Vinegar & Cider	2099	0.01539	0.0075	0.4678	7520
Tobacco Manufactured	2100	0.00273	0.0480	0.6190	323983
Cotton Goods	2211	0.00296	0.0529	0.3650	605100
Woolen Goods	2231	0.00413	0.0647	0.3587	302767
Carpet & Rug	2283	0.03927	0.0123	0.3838	56781
Felt Goods	2291	0.03420	0.0530	0.3570	9667
Cordage & Twine	2298	0.01430	0.0245	0.2480	37110
Lumber & Timber Pro.	2411	0.00209	0.0212	0.6831	517224
Lumber, Planning Mill	2412	0.00088	0.0221	0.4215	177145
Boxes, Wooden Packing	2421	0.00382	0.0517	0.4137	39543
Cooperage	2445	0.00513	0.0012	0.3709	29532
Wood Preserving	2491	0.10870	0.5252	0.2689	2934
Furniture	2500	0.00138	0.0559	0.5680	152712
Paper & Wood Pulp	2621	0.00283	0.0760	0.4110	277444
Envelopes	2642	0.03534	0.0808	0.4155	7495
Bags, Paper	2643	0.02396	0.0745	0.3462	11441
Wall Paper	2644	0.03570	0.0257	0.4730	12354
Boxes, Fancy & paper	2650	0.00443	0.1027	0.5474	22690
Printing & Publishing	2730	0.00126	0.0683	0.7121	142015
Lithographing	2752	0.01351	0.0550	0.6693	25537
Chemicals	2810	0.02681	0.1097	0.4421	96765
Dyestuffs & Extracts	2815	0.02250	0.0893	0.3731	14904
Salt	2819	0.02580	0.0491	0.5586	25586
Gas, Illumi. & Heating	2820	0.02460	0.0760	0.7029	725035

Table A-3 (Continued)

	SIC	MES	GR	VIS	K
<u>Industry</u>					
Paints	2851	0.01073	0.0671	0.3117	55783
Fertilizer	2871	0.00633	0.1391	0.3043	68917
Glue	2891	0.08772	0.0369	0.3835	10673
Explosives	2892	0.02688	0.0399	0.4189	42307
Bone, Carbone	2895	0.06220	0.1259	0.6860	1663
Fancy Article	2899	0.01710	0.0476	0.5965	7120
Petroleum Refining	2911	0.04648	0.1265	0.2035	136280
Paving Materials	2951	0.07576	0.6089	0.4703	5218
Roofing Materials	2952	0.01515	0.0408	0.4544	16925
Coke	2999	0.01832	0.0919	0.4229	90713
Rubber Goods	3011	0.02294	0.2552	0.3485	46297
Boot & Shoes, Rubber	3021	0.05650	-0.0232	0.5433	39411
Leather, Tanned, etc.	3111	0.00338	0.0454	0.2441	242584
Saddlery & Harness	3199	0.00564	0.0274	0.4350	29264
Glass	3211	0.00424	0.0546	0.6716	89389
Glass, Cutting, Stain.	3231	0.00833	0.0252	0.6312	7365
Cement	3241	0.01786	0.2406	0.5911	85758
Brick & Tile Terra...	3250	0.00109	0.0277	0.7569	230882
Gypsum	3275	0.01191	0.0628	0.5350	13203
Iron & Steel Bla. Roll.	3310	0.00456	0.0365	0.3150	936327
Wire	3315	0.14341	0.1159	0.2071	14899
Iron & Steel Pipe	3317	0.11647	0.1164	0.2674	13052
Smel. & Refi. Copper	3331	0.04193	0.0844	0.1830	76824
Smel. & Refi. Lead	3332	0.05412	-0.0077	0.0907	63822
Smel. & Refi. Zinc	3333	0.08557	0.1160	0.3130	23701
Smel. & Refi. Not Ore.	3399	0.16667	0.1293	0.2093	9807
Tinware	3411	0.02174	0.0956	0.3734	92555
Cutlery & Edge Tools	3423	0.01474	0.0372	0.6762	21810
Hardware	3429	0.01437	0.0602	0.6366	52884
Plumber's Supplies	3430	0.01969	0.1014	0.5393	20290
Stamped & Enamel. Ware	3461	0.02381	0.1966	0.5207	23107
Agri. Implements	3522	0.01920	0.0465	0.5690	196740
Foun. & Machin. Prod.	3530	0.00061	0.2585	0.5946	845024
Type Found. Printing	3555	0.05336	0.0126	0.7160	5925
Typewriters	3572	0.16108	0.1303	0.8242	16641
Electri. Machinery	3620	0.02740	0.1380	0.5250	174066
Sewing Machine	3636	0.13488	0.0025	0.6116	26695
Automobiles	3711	0.05235	1.7887	0.5625	20555
Auto. Bodies & Parts	3714	0.05917	3.7253	0.5593	2528
Shipbuilding, Steel...	3731	0.05000	0.0133	0.5280	101528
Locomotives	3741	0.10428	-0.0272	0.5348	38421
Cars, Railroad	3742	0.03211	0.0747	0.2895	88179
Bicycle & Tricycles	3751	0.05510	0.3033	0.5233	5883

Table A-3 (Continued)

	SIC [*]	MES	GR	VIS	K
<u>Industry</u>					
Photographic, Apparatus	3861	0.16700	0.2982	0.4210	7719
Silverware	3914	0.06667	-0.0044	0.5648	23910
Buttons	3963	0.01670	0.0860	0.6278	7783
Matches	3999	0.08333	0.1224	0.4183	5334

Source: U.S. Bureau of Census, Census of Manufactures, (Washington D.C.: U.S. Government Printing Office, 1905 and 1915); U.S. Bureau of Budget, Standard Industrial Classification Manual, (Washington D.C.: U.S. Government Printing Office, 1967).

* SIC indicates four-digit groups in the standard industrial classification of 1967.

Table A-4: Consolidated Firm Data on Profit Rates (PRF), Patents (PAT), Product Differentiation (PD), Tariffs (TA) and Initial Market Share (IMS)

	SIC	SF ^a	PRF ^b	PAT ^c	PD ^c	TA ^c	IMS ^d
<u>Name of Company</u>							
A Booth & Co.	2031	0	0.00	0	0	0	1
Acme Harvester Co.	3522	0	0.00	0	0	0	0
Alabama & Geor. Iron	3310	0	0.00	0	0	0	0
Ala. Conso. Coal & Iron	3310	0	0.00	0	0	0	0
Allis-Chalmers Co.	3522	1	4.05	1	0	1	1
Alpha Portland Cement	3241	1	n.a.	0	1	0	0
Amalgamated Sugar Co.	2063	1	n.a.	0	0	0	0
Ame. Automa. Weighing Machi.	3530	0	0.00	1	0	0	0
Ame. Machine & Ordnance	3530	0	0.00	0	0	0	0
Ameri. Agri. Chemi.	2871	1	4.70	0	0	1	1
Ameri. Caramel Co.	2070	1	2.09	0	1	0	1
Ameri. Oak Leather Co.	3111	1	n.a.	0	0	0	0
Ameri. Packer's Associ.	2033	0	0.00	0	0	0	0
Ameri. Pastry & Mfg. Co.	2050	0	0.00	0	0	0	0
Ameri. Pipe Mfg.	3317	1	n.a.	0	0	0	0
Ameri. Window Glass Machi.	3530	1	n.a.	0	0	0	0
Ameri. Wood Working Machi.	3530	0	0.00	0	0	0	1
America Coal Products	2820	1	9.77	0	0	0	1
America Axe & Tool	3423	1	n.a.	0	0	0	0
American Barrel & Package	2445	0	0.00	1	0	0	1
American Beet Sugar	2063	1	6.00	0	0	0	1
American Bicycle	3751	0	0.00	0	0	0	1
American Book Co.	2730	1	n.a.	0	0	0	1
American Box & Lumber	2421	1	n.a.	0	0	0	0
American Brass	3331	1	17.52	0	1	1	1
American Butter Co.	2021	0	0.00	0	0	0	0
American Can Co.	3411	1	5.65	0	0	0	1
American Car & Foundry	3711	1	4.41	1	0	0	1
American Cement Co.	3241	0	0.00	0	0	0	1
American Chicle Co.	2070	1	11.58	0	1	0	1
American Colortype Co.	2752	0	0.00	0	0	0	1
American Cotton Co.	2211	0	0.00	1	0	0	1
American Cotton Oil	2091	1	5.03	0	0	1	1
American Electric Heating	3620	0	0.00	0	0	0	1
American Felt Co.	2291	0	0.00	1	1	0	1
American Fisheries	2031	0	0.00	0	0	0	1
American Fork & Hoe Co.	3522	0	0.00	0	0	0	1
American Fruit Co.	2099	0	0.00	0	0	0	1
American Glue Co.	2891	1	9.93	0	0	1	1
American Grass Twine Co.	2298	0	0.00	1	0	0	1
American Hard Rubber	3011	1	n.a.	0	0	0	1
American Hardware Cor.	3429	1	n.a.	0	0	0	1

Table A-4 (Continued)

	SIC	SF	PRF	PAT	PD	TA	IMS
<u>Name of Company</u>							
American Hide & Leather Co.	3111	1	2.07	0	0	1	1
American Hominy	2043	1	n.a.	0	0	0	1
American Ice Co.	2097	1	2.41	0	0	0	1
American Laundry Machi.	3530	0	0.00	0	0	0	1
American Lithographic	3530	1	n.a.	0	0	0	1
American Locomotive Co.	3741	1	7.53	1	0	1	1
American Lumber Co.	2412	0	0.00	0	0	0	1
American Malting	2083	0	0.00	0	0	0	1
American Pneuma. & Service	3530	1	3.43	1	0	0	1
American Refractories Co.	3250	1	n.a.	0	0	0	1
American Saddlery & Harness	3199	0	0.00	0	0	0	1
American School Furni. Co.	2500	1	n.a.	1	0	0	1
American Seeding Machine	3522	1	7.19	1	0	1	1
American Sewer Pipe Co.	3250	1	n.a.	0	0	1	1
American Shipbuilding Co.	3731	1	6.22	0	0	0	1
American Smelting & Refining	3331	1	7.64	0	0	0	1
American Soda Founda. Co.	3530	1	n.a.	0	0	0	1
American Steel Foundries	3310	1	4.19	1	0	0	1
American Sugar Refining	2062	1	6.69	0	0	1	1
American Thread Co.	2211	1	5.71	1	0	1	1
American Tobacco Co.	2100	1	11.28	1	1	0	1
American Type Founders Co.	3555	1	5.51	0	1	1	1
American Window Glass	3211	0	0.00	0	0	0	1
American Woolen Co.	2231	1	5.98	0	0	1	1
American Wringer Co.	3530	0	0.00	0	0	0	1
American writing Paper Co.	2621	1	3.25	0	1	0	1
Anaconda Copper Co.	3331	1	13.58	0	0	0	1
Asphalt Company of America	2951	0	0.00	0	0	0	1
Associated Oil Co.	2911	1	3.13	0	0	0	0
Atlantic Rubber Shoe Co.	3021	0	0.00	0	0	0	1
Auto Weighing Machi.	3530	0	0.00	0	0	0	0
Baltimore Brick Co.	3250	0	0.00	0	0	0	0
Bigelow Carpet Co.	2283	1	n.a.	0	0	0	0
Bliss Co.	3530	0	0.00	0	0	0	0
Bon Air Coal & Iron	3310	0	0.00	0	0	0	0
Borden's Condens. Milk Co.	2023	1	n.a.	0	1	0	0
Butterick Company	2730	1	3.34	0	1	0	1
Califor. Fruit Canneries	2033	1	n.a.	0	1	1	0
Califor. Wine Associ.	2085	1	5.39	0	0	0	0
Cambria Steel Co.	3310	1	5.85	0	0	0	0
Casein Co. of America	2891	1	1.05	0	0	0	0
Celluloid Co.	2899	1	n.a.	0	1	0	0
Central Coal & Coke Co.	2999	1	n.a.	0	0	0	0
Central Foundry Co.	3317	1	n.a.	0	0	0	1

Table A-4 (Continued)

	SIC	SF	PRF	PAT	PD	TA	IMS
<u>Name of Company</u>							
Central Leather	3111	1	3.22	0	0	0	1
Central Stamping Co.	3461	1	n.a.	0	0	0	0
Chicago Pneumatic Tool	3530	1	7.24	1	0	1	1
Cleveland & Sand. Brewing	2083	1	3.90	0	0	0	0
Cleveland Akron Bag	2642	1	n.a.	0	0	0	0
Colonial Sugar Co.	2062	1	n.a.	0	0	0	0
Consoli. Railway Equip.	3742	0	0.00	0	0	0	1
Colorado Fuel & Iron Co.	3310	1	4.06	0	0	0	1
Consol. Rosendale Cement	3241	0	0.00	0	1	0	0
Consolidated Rubber Tire	3011	0	0.00	0	0	0	1
Continental Cotton Oil	2091	0	0.00	0	0	0	1
Continental Gin Co.	3530	1	n.a.	0	0	0	1
Corn Products Refining	2046	1	3.52	0	0	1	1
Crane's Nest Co.	2999	0	0.00	0	0	0	0
Croaker-Wheeler Co.	3620	1	5.29	0	1	0	1
Crucible Steel Co. of Ame.	3310	1	6.00	0	0	0	1
Cumberland Coal & Coke Co.	2999	0	0.00	0	0	0	0
Daylight Glass Mfg.	3211	0	0.00	0	0	0	0
Diamond Match Co.	3999	1	11.53	0	0	1	1
Distillers' Securities Cor.	2085	1	3.33	0	0	1	1
Distilling Co. of Ame.	2085	0	0.00	0	0	0	1
Dupont	2892	1	21.79	0	0	0	1
Eastman Kodak Co.	3861	1	33.61	0	0	0	1
Electric Vehicle Co.	3711	0	0.00	0	0	0	1
Electrical Boat Co.	3731	1	n.a.	0	0	0	0
Empire Steel & Iron Co.	3310	1	n.a.	0	0	0	0
Fay & Egan Co.	3530	0	0.00	0	0	0	0
Federal Chemical Co.	2871	0	0.00	0	0	0	0
Federal Lead Co.	3332	0	0.00	0	0	0	0
Federal Mfg Co.	3714	0	0.00	0	0	0	0
Fisheries Co.	2094	0	0.00	0	0	0	0
General Asphalt	2951	1	3.03	0	0	0	1
General Chem. Co.	2810	1	11.91	1	1	1	1
General Electric Co.	3620	1	13.41	1	0	0	1
General Railway Signal	3620	1	4.15	0	0	0	1
General Roofing	2952	0	0.00	0	0	0	1
Glucose Sugar Refining Co.	2062	0	0.00	0	0	1	1
Gottlieb... Brewing Co.	2082	0	0.00	0	0	0	0
Great Western Cereal Co.	2043	0	0.00	0	1	0	1
Green Conso. Copper Co.	3331	1	n.a.	0	0	0	0
Guggy Petroleum Co.	2911	0	0.00	0	0	0	0
Harbison-Walker Refrac. Co.	3250	1	5.70	0	0	0	1
Hartford Carpet Co.	2283	1	n.a.	0	0	0	0
Illinois Brick Co.	3250	1	n.a.	0	0	0	0
Inter. Nickel Co.	3399	1	11.01	0	0	0	1

Table A-4 (Continued)

	SIC	SF	PRF	PAT	PD	TA	IMS
<u>Name of Company</u>							
Inter. Steam Pump Co.	3530	1	5.05	0	0	1	1
International Car Wheel	3714	0	0.00	0	0	0	1
International Fire Engine	3714	1	n.a.	0	0	0	1
International Harvester Co.	3522	1	8.82	1	1	1	1
International Paper Co.	2621	1	4.44	0	0	0	1
International Power Co.	3620	0	0.00	1	0	0	1
International Pulp Co.	2621	0	0.00	0	0	0	0
International Silver Co.	3914	1	5.35	0	1	0	1
Johns Manville Co.	2952	1	8.37	0	0	0	0
Kirby Lumber Co.	2411	1	n.a.	0	0	0	0
Miss. Wire Glass Co.	3231	1	n.a.	1	0	0	0
Mt. Vernon-Woodberry Cotton	2211	0	0.00	0	0	0	1
Nati. Ena. & Stamping Co.	3461	1	3.87	0	1	1	1
National Asphalt	2951	0	0.00	0	0	0	1
National Biscuit Co.	2050	1	9.31	0	1	0	1
National Candy Co.	2070	1	3.31	0	1	1	1
National Car Wheel Co.	3714	1	7.99	1	0	0	0
National Carbon Co.	2895	1	10.56	1	0	0	1
National Casket Co.	2491	1	n.a.	0	0	0	1
National Cordage	2298	0	0.00	0	0	0	1
National Fireproofing Co.	3250	1	3.22	1	0	0	1
National Glass Co.	3231	0	0.00	0	0	1	1
National Lead	3332	1	5.58	0	0	0	1
National Novelty Cor.	2899	0	0.00	0	0	0	1
National Rice Milling	2041	0	0.00	0	0	0	0
National Salt	2819	1	n.a.	0	0	0	1
National Shear	3530	0	0.00	0	0	0	1
National Wallpaper	2621	0	0.00	0	0	0	1
New England Brake Co.	3250	0	0.00	0	0	0	0
New England Cotton Yarn	2211	0	0.00	0	0	0	1
New Jersey Zinc	2810	1	n.a.	0	0	0	1
Otis Elevator Co.	3530	1	6.76	1	0	0	1
Pacific Coast Biscuit	2050	0	0.00	0	0	0	0
Pacific Starch Co.	2046	0	0.00	0	0	0	0
Penn. Central Brewing Co.	2082	0	0.00	0	0	0	0
Penn. Coal & Coke Co.	2999	0	0.00	0	0	0	0
Penn-Ameri. Plate Glass	3211	0	0.00	0	0	0	0
People's Brewing Co.	2082	0	0.00	0	0	0	0
Pittsburgh Brewing Co.	2082	1	5.98	0	0	0	0
Pittsburgh Plate Glass Co.	3211	1	9.86	0	0	0	1
Pocahontas Collieries Co.	2999	0	0.00	0	0	0	0
Pope Manufac. Co.	3751	0	0.00	0	0	0	1
Pressed Steel Car Co.	3742	1	5.11	0	0	0	1
Pullman Co.	3742	1	9.88	1	0	0	1
Pure Oil Co.	2911	1	n.a.	0	0	0	1

Table A-4 (Continued)

	SIC	SF	PRF	PAT	PD	TA	IMS
<u>Name of Company</u>							
Quaker Oats Co.	2043	1	10.18	0	1	0	1
Railway Steel Springs	3741	1	5.57	1	0	0	1
Republic Iron & Steel Co.	3310	1	4.34	0	0	0	1
Rochester Opti. & Camera	3861	0	0.00	0	0	0	0
Rocky Mt. Paper	2621	0	0.00	0	0	0	0
Royal Baking Powder	2098	1	n.a.	0	1	0	1
Seacoast Canning Co.	2031	1	n.a.	0	0	0	0
Sequehanna Iron & Steel	3310	0	0.00	0	0	0	0
Sherwin-Williams Co.	2851	1	n.a.	0	0	0	0
Sloss-Sheffield Steel	3310	1	4.37	0	0	0	0
Springfield Breweries Co.	2082	1	n.a.	0	0	0	0
Standard Rope & Twine Co.	2298	0	0.00	0	0	0	1
Standard Sanitary	3430	1	n.a.	0	0	1	1
Standard Wall Paper Co.	2644	1	n.a.	0	0	0	0
Temple Iron Co.	3310	0	0.00	0	0	0	0
Tide Water Steel Co.	3310	0	0.00	0	0	0	0
Torrington Co.	3636	1	n.a.	0	0	0	0
U.S. Cast Iron Pipe & .. Co.	3317	1	2.73	0	0	0	1
U.S. Cotton Duck Cor.	2211	0	0.00	0	0	0	1
U.S. Dyewood & Extract	2815	0	0.00	0	0	0	1
U.S. Envelope Co.	2642	1	10.21	0	0	0	1
U.S. Finishing Co.	2211	0	0.00	0	0	0	1
U.S. Flour Milling	2041	1	n.a.	0	0	0	1
U.S. Glass Co.	3211	1	4.04	0	0	0	1
U.S. Gypsum Co.	3275	1	5.90	0	0	0	1
U.S. Leather Co.	3111	0	0.00	0	0	0	1
U.S. Playing Card Co.	2899	1	n.a.	0	0	0	1
U.S. Worsted Co.	2231	0	0.00	0	0	0	1
U.S. Shipbuilding Co.	3731	0	0.00	0	0	0	1
U.S. Smelting, ..& Mining	3310	1	7.55	0	0	0	1
U.S. Steel Corporation	3310	1	7.51	1	1	0	1
U.S. Whip Co.	3199	0	0.00	0	0	0	0
Union Bag & Paper Co.	2643	1	2.70	1	1	1	1
Union Carbide Co.	2810	1	n.a.	1	0	0	0
Union Iron & Steel Co.	3310	0	0.00	0	0	0	0
Union Typewriter Co.	3572	1	n.a.	1	1	1	1
Union Waxed Paper Co.	2621	0	0.00	0	0	0	0
United Box Board & Paper Co.	2650	0	0.00	1	0	0	1
United Breweries	2082	1	1.28	0	0	0	0
United Button Co.	3963	0	0.00	0	0	1	1
United Engi. & Foundry Co.	3530	1	n.a.	0	0	0	0
United Fruit Co.	2033	1	10.92	0	0	0	1
United Shoe Machine	3530	1	14.25	1	0	0	1
United States Rubber Co.	3011	1	6.42	0	0	0	1
United Wire & Supply Co.	3315	1	n.a.	0	0	0	0
United Zinc & Lead	3333	0	0.00	0	0	0	1

Table A-4 (Continued)

	SIC	SF	PRF	PAT	PD	TA	IMS
<u>Name of Company</u>							
Vir. Caro. Chem. Co.	2871	1	5.45	0	0	0	1
Virgi. Iron, Coal & Coke	2999	1	1.67	0	0	0	0
Vulcan Detinning Co.	3399	1	3.39	0	0	0	0
Washburn Wire Co.	3315	1	n.a.	0	0	0	0
Yellow Pine Co.	2421	0	0.00	0	0	0	0

Source: John Moody, The Truth About the Trusts, (New York: Moody Publishing Co., 1904). Moody's Manuals of Industrial Securities, 1905-1915. Shaw Livermore, "The Success of Industrial Mergers," Quarterly Journal of Economics, 50, (November 1935), pp.68-95.

- ^a SF represents firm's success or failure. "1" indicates success, "0" failure.
- ^b Profit is average annual rate during 1905-1915.
- ^c PAT, PD and TA are dummy variables. That is 1 if the firm took a strategy of patents, product differentiation or tariff protection; 0 otherwise.
- ^d IMS is also dummy variable. That is 1 if the firm has enough market share to influence the market; 0 otherwise.

Table A-5: Statistical Summary of Dependent and Independent Variables

Variable	Unit	Mean	Standard Deviation	Minimum	Maximum
SF	Dummy	0.592	0.493	0.0000	1.0000
PRF	%	3.22	4.72	0.0000	33.6
MES	%	0.026	0.036	0.0003	0.1670
VIS	%	0.452	0.173	0.0901	0.8242
K	\$	13.59	1.296	9.4441	16.697
GR	%	0.181	0.512	-0.0272	3.7253
PAT	Dummy	0.145	0.353	0.0000	1.0000
PD	Dummy	0.114	0.319	0.0000	1.0000
TA	Dummy	0.132	0.339	0.0000	1.0000
IMS	Dummy	0.614	0.488	0.0000	1.0000

VITA

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