AN ANALYSIS OF AIRLINE MERGERS: 1951 TO 1972

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ABSTRACT

AN ANALYSIS OF AIRLINE MERGERS: 1951 TO 1972

By

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The purpose of the research was to investigate merger activity in the air transport industry, a regulated sector of the economy. The research examined mergers from 1951 to 1972 on an ex ante basis.

The research consisted of two principal parts corresponding to two approaches used to obtain information about airline mergers. One part examined reasons advanced as to why airlines propose mergers and the reasons cited by or attributed to the Civil Aeronautics Board (CAB) for its approval or disapproval of merger applications. The conclusions for this part of the research were based on an interpretation of an extensive review of the available literature on airline mergers and on CAB decisions on mergers. The other main part of the research used a statistical technique, multiple discriminant analysis, to analyze airline merger activity. After data were selected to represent relevant airline characteristics, the technique was used to test whether a statistical difference between various pairs of groups of airlines representing their merger activities was accomplished by the data input. When a difference was found between a pair of groups, the technique was able to predict the classification of the airlines into these groups. Significant characteristics of the airlines were identified for the groups predicted.

The significant reasons why airlines merge found in the literature were (1) to achieve economies of scale, (2) to take advantage of a bargain price, (3) to improve management, (4) to reduce business and financial risk, (5) to affect tax savings, (6) to grow rapidly, (7) to improve service and increase demand, (8) to increase monopoly power and (9) to correct or alleviate financial difficulties.

The board has expected airlines to benefit from mergers because of (1) economies of scale, (2) the replacement of inefficient management, (3) a reduction in business and financial risk, (4) tax savings and (5) the improvement of service and increases in demand. For the mergers examined, the CAB required for approval that the price be reasonable, the protective labor provisions be satisfactory, and the merger not create a monopoly, jeopardize another carrier, nor cause significant diversion of traffic.

Multiple discriminant analysis indicated that (1) The airlines proposing to be the acquiring airlines exhibited better financial, operating and route characteristics than those airlines not proposing mergers and those airlines proposing to be acquired. (2) Furthermore, those airlines not proposing mergers revealed more favorable financial, operating and route characteristics than those airlines proposing to be acquired. (3) Both the airlines proposing to be acquired which were disapproved for merger by the CAB and those airlines proposing to be the acquiring airlines which were approved by the board showed more favorable financial, operating and route characteristics than those airlines proposing to be acquired which were approved. (4) No differences in the financial, operating and route characteristics of airlines were found between those airlines proposing to be the

acquiring airlines which were disapproved by the CAB and either the airlines proposing to be the acquiring airlines which were approved by the board or the airlines proposing to be acquired which were disapproved by the CAB.

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CHAPTER I

INTRODUCTION

A substantial amount of research on mergers has been done in recent years but disagreement still exists about both the characteristics of merging firms and the reasons for mergers. While studies of the reasons for mergers have dealt with specific industries, the air transport industry has not been examined. The absence of merger research for the air transport industry is not consistent with (1) the degree of merger activity and merger discussion in the airline industry; (2) the significance of this industry; (3) the amount of attention focused on this industry by the public, government, and the business community; (4) the efforts of many airlines to merge in the recent past; and (5) the actual and potential impact of mergers on the structure of the industry.

The purpose of this research was twofold. One purpose was to try to identify the reasons why firms merge in the air transport industry based on available information and to examine the decisions of the Civil Aeronautics Board (CAB) in approving or disapproving merger proposals. The second was to use a quantitative technique, multiple discriminant analysis, to analyze airline merger activity. Discriminant analysis was used in an attempt to obtain information about mergers by dividing the airlines into several groups representing merger activity in order to identify the characteristics of the firms in these groups. The research evaluated mergers on an ex ante basis.

CHAPTER II

GENERAL REASONS FOR MERGERS

Introduction

This chapter presents the results of a review of the general literature, made to identify reasons cited for mergers and/or the factors considered in mergers. Reasons common to many mergers were selected rather than reasons unique to specific mergers. The findings from the survey were used to help identify the reasons for mergers in the air transport industry.

The literature on the reasons for mergers and the factors considered in mergers is extensive, but not definitive. There is no universally accepted theory to explain why mergers occur. The literature is of two types. One type is general in nature; the intent is to provide broad generalizations rather than to provide detailed knowledge about specific mergers or mergers in a particular industry. The findings of this type of approach were suitable for this chapter. The second type of the literature deals with specific mergers in detail with little attempt made to provide generalizations. Such studies resulted in a diversity of conclusions which are less applicable to mergers in general.

Reasons for Mergers

Although many reasons for mergers have been advanced in the literature, it was possible to recognize several common concepts.

Undoubtedly, each merger has its unique properties, but most also have properties common to other mergers. The task was to summarize the reasons for a list useful to this research. Thus, the procedure followed was to list the common motives acknowledged by the literature.

If wealth maximization is the objective of the firm, the only reason for merger is to maximize the long-run wealth of stockholders. The objective of any merger, therefore, should be to increase the market value of the firm over what it would have been had the merger not taken place. Hence, a merger would be evaluated as any capital budgeting project. This idea was supported by Alberts,[1] Archer and D'Ambrosio,[2] Weston and Brigham,[3] Schwartz[4] and Van Horne.[5] Other authors such as McCarthy,[6] Butters and Lintner,[7] and Mace and Montgomery[8] referred to mergers as an investment decision, but the objective of maximizing market value was not stated.

Alberts summarized the merger decision as an interaction of the future dividend stream and its effect on the cost of capital; therefore, the merger decision ultimately involves share price. He stated that given the assumption of "intrinsic value" of the exchange prices in mergers, that is, efficient valuation in merger transactions, the only possible motive for mergers is synergism due to economies of scale or to increases in demand brought about by entering a related industry. Alberts maintained that economies of scale can be achieved by increasing market share, but that this usually is not feasible, and that economies of scale can be affected by horizontal mergers, but this is usually not legal. Therefore, synergistic effects mainly are due to resulting increases in demand. He also noted that mergers undertaken in response to increases in demand are less likely to be

profitable than internal growth and that mergers to reduce risk are redundant because investment portfolios presumably already have accomplished this objective for investors, thus making corporate diversification unnecessary.

When the assumption of efficient pricing or "intrinsic value" in mergers is dropped, there arises another motive in addition to synergism--the possibility of achieving gains because of "bargains" or "bargain prices." Alberts listed four types of bargains: (1) forecast, (2) cost of capital, (3) mismanagement and (4) tax.

Forecast bargains occur because sellers underestimate the future dividend stream. Cost of capital bargains occur if small firms are systematically capitalized at a higher rate than large firms. If larger firms acquire smaller firms, a lower capitalization rate for the combined entity can achieve higher total value. This cost of capital difference can be due to the poorer marketability of the smaller firm's shares in secondary markets and/or its higher cost of funds in the primary markets.

Mismanagement bargains exist because inept practices can be changed after a merger. For example, the acquired firm may have excess liquidity which the acquiring firm could exploit. Tax bargains can occur because of the institutional and legal advantages of certain mergers.

Alberts doubted that synergistic effects are common and, therefore, without the possibility of effecting mergers at bargain prices, there would be few occasions in which firms would find it worthwhile to grow in this manner. He continued that since bargain prices are common, however, mergers are an important means of exploiting investment

opportunities. When mergers can be affected at bargain prices, there are two investment opportunities--synergism and bargains--that can be exploited profitably by mergers as well as by internal means. The synergistic effects are due to economies of scale effected by expanding in the same market and to increases in demand effected by expanding in a related market.

Economies of Scale. This reason was frequently mentioned in the literature, and it is clearly defined in the economies. Economies of scale are represented by the declining portion of a long-run average cost curve, where each point represents the lowest cost for a given output.

Economies of scale are due to many factors--production, administrative, distribution, sales promotion, research consolidation and financing economies of scale. For example, Weston and Brigham, Van Horne, Archer and D'Ambrosio, McKenna,[9] McCarthy, Mace and Montgomery, Lintner,[10] Alberts, Erler,[11] Johnson,[12] Galah[13] and Weiss[14] supported the theory that economies of scale are a reason for mergers.

Economies of scale can be achieved either by growth through merger or by internal growth if a firm is of suboptimal scale. Why would the firm choose to grow by merger rather than choosing to grow internally? It may be because a firm cannot achieve its optimal scale due to structural constraints in its industry; for example, a firm may not be able to increase its market share because of competition. A firm may prefer growth by merger to gain economies of scale because a merger can offer bargain prices which internal growth does not. Economies of scale can be an important reason for growth either by internal means or by merger.

Monopoly Power. Mergers can be motivated by the desire to gain monopoly power by increasing the size of the firm. This motive is often disguised as an attempt to achieve scale economies. Monopoly power increases the surviving firm's control over supply, and in unregulated industries, its control over prices. The Federal Trade Commission's (FTC) Economic Report on Corporate Mergers[15] concluded that many mergers are attempts to achieve monopoly power. Alberts, Weston and Brigham, Lintner, McKenna and McCarthy also recognized this motive.

The antitrust laws exist to control the lessening of competition and increases in monopoly or market power. However, in the air transport industry, if the CAB approves a merger this merger is exempt from antitrust action. Of course the CAB has not ignored antitrust considerations in its merger decisions. The CAB's responsibility for maintaining competition in the industry and the court's interpretation of the CAB's statutory requirements of this matter are discussed later. The Securities and Exchange Commission (SEC) requires disclosure of merger information, but it does not judge the merits of a particular merger.

Economies of scale have been linked erroneously to mergers whose purpose is to eliminate excess capacity in an industry. A merger to achieve the "rationalization" of surplus capacity can be beneficial to the combined firm, but the true source of the economies is not due to increased size but to the fact that inefficient firms and excess capacity have been allowed to exist because of monopolistic conditions or because excess capacity has been imposed by regulatory policy in a regulated industry affected by monopolistic elements. In

effect, economies can occur because of mergers which increase monopoly power in an industry already affected by monopolistic elements, not because of true economies of scale which are the result of efficient operations in a firm and industry.

Increases in Demand. A merger can be motivated by the desire to increase the total demand of the combined firm. An increase in demand can occur because of the complementarity of the firm's products or services, or because one firm's reputation or brand name favorably carries over to the combined firm. Alberts, Mace and Montgomery, Van Horne, Friedman[16] and McKenna supported this reason.

Acquiring Management Skills. This reason was widely acknowledged in the literature. It was recognized by Weston and Brigham, Van Horne, Alberts, McCarthy, Butters and Lintner, Mace and Montgomery, Harvey and Newgarden,[17] and Hutchinson.[18] The objective of a merger may be to replace mismanagement or to acquire superior management skills. Also included here is the desire to acquire the skills of research or technical personnel.

This reason is meaningful only if the transaction price of the merger is low enough to make the merger attractive to the buyer.

Forecast Bargains. Buyers and sellers can estimate the future earning power of a firm differently. Sellers may underestimate the future earning power of their firm or buyers may overestimate the future earning power of the selling firm; in either case, a bargain price will appear to exist from the buyer's point of view. Gort,[19] Alberts, Weston and Brigham, and Mace and Montgomery supported the motive of bargain prices.

Michael Gort tested various hypotheses of reasons for mergers such as attempts to reduce competition or to achieve economies of scale. He concluded that the best explanation for mergers was that economic disturbances to the firm, such as growth and technological innovation, caused valuation problems and dispersions among potential owners and the actual owners which, in turn, increased the probability of merger. Those industries experiencing more mergers were characterized by more economic disturbances.

Risk Reduction. Alberts stated that "cost of capital bargains" can occur if small firms are systematically capitalized at a higher rate than large firms. Similarly, Lintner stated that mergers are motivated by a divergence in price-earnings ratios because of size differences. Business risk and financial risk can be reduced by merger. The reduction of business risk was cited by Weston and Brigham, Van Horne, McKenna, McCarthy, Mace and Montgomery, Lintner and Alberts. A reduction in business risk stabilizes earnings and thereby lowering borrowing costs and increasing debt capacity. Lewellen argued that mergers can increase debt capacity even if the combining firms have optimal capital structures.[20] Also, one firm may have unused debt capacity that the other firm in the merger would like to utilize.

Tax Advantages. A merger may take place in order to apply an existing tax loss which could not otherwise be utilized as an offset to profits. Some mergers are tax-free if they are deemed to be a reorganization by the IRS. Many mergers are called nontaxable, but actually they are tax-postponed. Taxes are deferred on any gains in a merger transaction involving stock payment until the securities are

sold, whereas in a cash transaction any gain is taxable immediately. If the gains are deferred long enough, they will be taxed as capital gains rather than ordinary income.

Alberts stated that mergers occur because of tax bargains. Bosland found taxes to be important in motivating smaller firms to merge.[21] Butters and Lintner found taxes to be an important reason for mergers for the acquired firm. The Federal Trade Commission's Economic Report on Corporate Mergers, Harvey and Newgarden, and Van Horne noted that taxes are a reason for mergers. However, the price of the merger must be low enough to make the tax advantages worthwhile.

Accounting Advantages. A merger may have accounting advantages over ordinary investments or purchases. The Federal Trade Commission, in its Economic Report on Corporate Mergers, was concerned that many mergers have taken place because of the significance of accounting considerations.

The accounting profession has had extensive debate on how to record mergers. The major issue concerns purchase versus pooling-of-interests merger accounting. If the merger is transacted by cash payment, there is no problem since this is a clear purchase. The debate on which accounting method to use arises when the merger is transacted by stock payment. The alternative accounting methods are significant, primarily in their effect on the determination of profits and EPS of the combined firm. In a "purchase" the excess of the purchase price over the book value of the assets is allocated to goodwill; goodwill is not tax deductible and it is amortized against revenue over future years, usually ten. This amortization depresses earnings. On the other hand, if a merger is accounted for by the

pooling-of-interests method, the assets are transferred or pooled at book value regardless of whether or not the purchase price exceeds book value. Hence, no goodwill arises to depress earnings of the combined entity. However, purchase accounting is preferred by the acquirer in the unusual instances of book value exceeding the purchase price because purchase accounting will allow higher EPS than pooling-of-interests accounting.

The advantage of the pooling-of-interests method is clear. If a firm can acquire assets through mergers at prices comparable to those demanded by the market for the purchase of the assets, then it pays the firm to account for the assets at less than market value; that is, at book value in pooling-of-interests in order to report higher earnings. Of course, this logic assumes that it is in the best interest of the firm to report the highest possible earnings as early as possible. In addition, the price of the merger must be deemed a bargain, taking into consideration the accounting advantages and other benefits, for the merger to be deemed advantageous.

Financial Difficulties. A firm may be motivated to merge in order to alleviate financial problems. The U.S. Senate's Hearings, Economic Concentration supported this theory.[22] It is difficult, however, to establish this since a firm would be unlikely to admit to such a motive for reasons of prestige, financing and bargaining power considerations. Moreover, there can exist a considerable latitude of opinion as to what constitutes financial difficulties and its relative severity.

Rapid Growth. This reason represents the idea of growth through merger for the purpose of rapid growth, without considering the possible

benefits of mergers such as economies of scale or reducing risk. Growth by merger can take place much quicker than growth by internal means. Rapid growth merely to increase the size of the firm may be desired for prestige, personal satisfaction or enhanced power. Promotional profits also can motivate growth for the sake of growth; for example, many of the congolomerate mergers of the 1960s appear to have been motivated by the desire to build an empire.

Reid concluded that merger active firms were oriented toward sales growth rather than profitability, whereas more internal growth firms were more profitable but grew less in terms of sales.[23] McCarthy, Mace and Montgomery, Weston and Brigham, Van Horne and McKenna supported this reason.

Method of Financing Expansion. A merger can be financed at times when it is not possible to finance internal growth. It may be possible to use stock or convertible securities in an exchange when it might be impossible, or at least more costly, to raise cash by selling stock or by borrowing in order to purchase the assets. The use of securities in mergers reduces cash requirements for the acquisition of assets. Sellers may be more willing to accept the stock of the acquirer than would investors in a public distribution. By using securities in mergers a firm may avoid an upward sloping investor supply curve for capital. In addition, a stock transaction may be cheaper to the buyer in a merger because of the tax laws discussed previously, and also because of the underwriting fees and discounts necessary when the stock is sold. A stock transaction can permit favorable accounting treatment. Convertible securities have been popular for merger payments. Convertible securities can be advantageous if common stock

prices are temporarily depressed because they do not immediately depress EPS, because they may be used in mergers when they could not be sold publicly, and because the dividend payouts of the respective common shares may be too divergent. Of course, the price of the merger must be low enough to make this financing alternative for acquiring assets attractive.

Liquidity. A firm may be acquired because it offers liquid assets that the acquiring firm wishes to utilize. Alberts, Weston and Brigham, and Van Horne stated that excess liquidity can be important in evaluating merger candidates; however, the merger must still be viewed as a bargain.

Quantitative Considerations in the Pricing of Mergers

Although there is a considerable amount of literature on the specific factors or criteria which determine merger valuations, this literature does not discuss factors considered in evaluating prospective mergers; that is, the focus is on valuation problems after the decision that the merger would be desirable if the price is acceptable has somehow been decided. Therefore, if the valuation indicates that the price of the merger is a bargain, then the merger is attractive. Lynn Dellenbarger, for example, focused on factors determining valuation and exchange ratios (the most important variables were earnings per share, market price, dividends and book value per share) but he did not focus on factors determining the attractiveness of mergers which would precede such valuation considerations.[24]

Several books composed of articles by a variety of experts who participated in acquisitions discuss factors used to evaluate potential

mergers and their varying weights from merger to merger.[25] The articles reveal that financial criteria such as existing return on investment, expectations of growth and liquidity are important in evaluating acquisitions.

J. Fred Weston argued that it is necessary to consider factors which influence the price to be paid, since it is the single most important consideration.[26] The important quantitative factors in determining the transaction price are the per share values of earnings, dividends, net current assets, market values, book values and growth rates, although qualitative factors often are the overriding determinant of merger terms. He stated that the relative importance of each quantitative factor will vary in mergers and that the qualitative considerations may suggest that synergistic effects may be present to warrant paying more for the acquired firm than the quantitative factors alone would suggest. In discussing the relative importance of the quantitative factors he stated, "Attempts have been made to determine statistically the relative weights assigned to each of these factors in actual merger cases. However, these attempts have been singularly unsuccessful--in one case, one factor seems to dominate; in another case some other determinant appears to be the most important. This absence of consistent patterns among quantitative factors suggests that qualitative forces are also at work."[27] Again, the focus here was on the valuation problem.

According to Van Horne, important quantitative factors affecting a merger are earnings per share for both corporations, the effect the merger has on the earnings per share of the surviving corporation, future earnings for the combined firm, the market prices per share for

the two firms, the price-earnings ratios, the size of the respective firms, working capital per share, book value, estimates of future cash flows and the effect on the business risk of the firms.[28]

Conclusion

The literature reviewed expressed many common views. Conclusions as to the causes of mergers and the factors considered in their evaluation were often the same although individual articles displayed some degree of diversity in their findings and differences in their conclusions. Although a merger could have a unique reason most have reasons common to other mergers; it was possible to recognize common concepts throughout the literature.

FOOTNOTES

[1]William W. Alberts, "The Profitability of Growth by Merger," in The Corporate Merger, edited by William W. Alberts and Joel E. Segall, pp. 235-87, (Chicago: University of Chicago Press, 1966).

[2]Stephen H. Archer and Charles A. D'Ambrosio. Business Finance: Theory and Management (New York: Macmillan Company, 1966), pp. 391-400.

[3]J. Fred Weston and Eugene F. Brigham. Managerial Finance (New York: Holt, Rinehart and Winston, 1969), pp. 688-92.

[4]Samuel Schwartz, "Merger Analysis as a Capital Budgeting Problem," in The Corporate Merger, pp. 139-50.

[5]James C. Van Horne. Financial Management and Policy (Englewood Cliffs, N. J.: Prentice-Hall, 1968), pp. 471-73.

[6]George McCarthy, "Premeditated Merger," in Foundations for Financial Management, edited by James Van Horne, pp. 565-80 (Homewood, Ill.: Richard Irwin, 1966).

[7]Keith Butters and John Lintner, "Tax and Non-tax Motivations for Mergers," in Elements of Financial Administration, edited by John O'Donnell and Milton Goldberg, pp. 629-51 (Columbus, Ohio: Charles Merrill Books, 1962).

[8]Myles Mace and George Montgomery. Management Problems of Corporate Acquisitions (Boston: Harvard University Press, 1962).

[9]William E. McKenna, "Merger, An Art and a Science," in Readings in Finance, edited by Harold Wolf and Lee Richardson, pp. 349-50, (New York: Appleton-Century-Crofts, 1966).

[10]John Lintner, "Expectations, Merger and Equilibrium in Purely Competitive Securities Markets," American Economic Review 61, no. 2 (May, 1971):109-14.

[11]Raymond Erler, "Mergers in the Savings and Loan Industry," in Dissertation Abstracts, August 1969, p. 441A.

[12]Craig Johnson, "An Economic and Regulatory Analysis of the Merger and Consolidation Movement in the Motor Trucking Industry," in Dissertation Abstracts, 1971, p. 61A.

[13]Fath El-Bab Galah, "An Analysis of a Decade of Property and Liability Insurance Company Mergers, 1950-1959," in Dissertation Abstracts 26, 04, p. 1960, 1964.

[14]Using the survivor technique, Weiss estimated that from 83-91 percent of the capacity acquired through mergers in the steel, auto, petroleum, cement, flour and brewing industries between 1929-1958 was of suboptimal scale. Leonard Weiss, "An Evaluation of Mergers in Six Industries," Review of Economics and Statistics, May 1965, pp. 172-81.

[15]Federal Trade Commission. Economic Report on Corporate Mergers. Hearings on Antitrust and Monopoly, Committee of the Judiciary, U.S. Senate, 91st Congress, 1st sess., part 8A, USGPO, 1969.

[16]Milton N. Friedman, "The Research and Development Factor in Mergers and Acquisitions," Study No. 16, U.S. Senate, Committee on the Judiciary, Subcommittee on Patents, Trademarks, and Copyrights, Washington, D.C., 1958.

[17]John Harvey and Albert Newgarden, Management Guides to Mergers and Acquisitions (New York: John Wiley and Sons, 1969).

[18]G. S. Hutchinson, ed., The Business of Acquisitions and Mergers (New York: Presidents Publishing House, 1968).

[19]Michael Gort, "An Economic Disturbance Theory of Mergers," Quarterly Journal of Economics, November 1969, pp. 624-42.

[20]Wilbur Lewellen, "A Pure Financial Rationale for Conglomerate Mergers," Journal of Finance 26 (May 1971):521-37.

[21]C. C. Bosland, "Has Estate Taxation Induced Recent Mergers?" National Tax Journal, June 1963, pp. 159-68.

[22]Hearings, Economic Concentration. Washington, D.C.: U.S. Senate, Committee on the Judiciary, Subcommittee on Antitrust and Monopoly, 1964.

[23]Samuel R. Reid. Mergers, Managers and the Economy (New York: McGraw-Hill, 1968), pp. 153-264.

[24]Lynn Dellenbarger, Common Stock Valuation in Industrial Mergers (Gainesville: University of Florida Press, 1966).

[25]John Harvey and Albert Newgarden, Management Guides to Mergers and Acquisitions (New York: John Wiley and Sons, 1969) and G. S. Hutchinson, ed., The Business of Acquisitions and Mergers (New York: Presidents Publishing House, 1968).

[26]J. Fred Weston and Eugene Brigham, Managerial Finance (New York: Holt, Rinehard and Winston, 1969), p. 692.

[27]Ibid., p. 698.

[28]James Van Horne. Financial Management and Policy (Englewood Cliffs, N.J.: Prentice Hall, 1967), pp. 473-86.

APPENDIX A

CHAPTER IV

VARIABLE SELECTION AND GROUP PAIRINGS OF AIRLINES USED IN THE MULTIPLE DISCRIMINANT ANALYSES

Introduction

This chapter discusses the variables that were used in the multiple discriminant analyses of merger activity. The twenty-six variables discussed in this chapter were all used in the multiple discriminant analyses. This chapter also discusses the group pairings of airlines that were used in the discriminant analyses.

The qualitative portion of the research identified the reasons which the airlines have had to merge and the reasons which the CAB has had to approve or disapprove mergers. There were two objectives of the qualitative research. The first objective was to examine the reasons for mergers, and the second objective was to provide a partial guide for the subjective selection of a set of variables for use in the quantitative analysis.

Variable Selection

The task was to attempt to select variables which could discriminate between the groups of airlines used in the multiple discriminant analyses. The selection process was subjective using the information developed in the earlier chapters as a guide.

The variables were selected on the basis of their ability to represent important airline characteristics. Variables were chosen to represent the airlines' profitability, leverage, liquidity, activity and efficiency, size and capacity, route characteristics, investment and costs. Variables which have been used in financial research and which have been supported in the financial literature were examined for their possible usefulness to this research. A limiting factor was the availability of data for all the merger cases and the consistency of data over time.

Preliminary discriminant analyses revealed six variables possessing discriminating ability; they were retained in the second set of variables for use in the subsequent discriminant analyses. The discriminant analyses were repeated to further test the hypothesis that merger activity could be partially represented quantitatively.

The specific variables chosen to represent characteristics of the airlines are described below.

Profitability. Measures of profitability generalize a firm's overall effectiveness and the net result of many factors affecting the firm.

1. Net income/total assets. The rate of return on investment is the basic regulatory standard used to judge the adequacy of the industry's and individual carriers' profitability and to determine allowable rate levels for the industry. It is a summary measure of how effectively a firm employs its total assets.

2. Earnings before interest and taxes/total assets. In contrast to the rate of return on investment, this ratio, which is the net operating

rate of return on investment, provides a means of comparison between firms independent of the way the firm is financed.

3. Net income/stockholder's equity. The rate of return on equity is used as a regulatory standard in conjunction with the rate of return on investment to determine the adequacy of the airlines' profitability. It is the basic measure of the return on the owner's investment in a firm.

4. Earnings per share. This figure is very important to the common stockholders as a source of dividends and as a determinant of market price.

Leverage. Leverage or debt ratios and variables measure the extent to which the firm has been financed by debt. They measure the contribution of the owners as compared to the financing provided by creditors. Creditors look to the equity funds to provide a margin of safety. Firms with low leverage ratios have less risk, and high debt ratios increase the difficulty of borrowing. Industry norms are important in the capital market's appraisal of a company's financial condition or strength. If a company is materially out of line with the rest of the industry, it may be penalized in various ways by creditors, therefore, it is usually important for a company to avoid being atypical in the investment markets as far as capital structure is concerned.

5. Total debt/equity. The debt to equity ratio shows creditor funds in relation to equity funds. From the point of view of the creditor, the lower the percentage of creditor funds employed, the better.

6. Long-term debt/total capitalization. Total capitalization is long-term debt plus net worth. This ratio reflects the relative importance

of long-term debt in the capital structure. The debt of a firm is most commonly expressed by this ratio although it is not very adequate in providing evidence on the real risk of debt--the inability of the firm to make mandatory cash payments or cash payments important to the long-run health of the firm.

7. Total debt/total assets. This ratio, generally called the debt ratio, measures the percentage of funds that have been provided by creditors. Total debt includes current liabilities and all long-term debt. The percentage of creditor funds being used to finance the firm is a pertinent measure of the financial risk the firm has assumed.

Liquidity. Liquidity ratios are used to judge a firm's ability to meet short-term obligations. The ratios usually deal with cash, near cash items, assets that will covert to cash in the normal course of operations and obligations maturing in one year, including the maturing principal portion of long-term debt.

8. Liquid assets/current liabilities. Probably the most frequently used liquidity measure is the current ratio or current assets/current liabilities. The current ratio is the generally accepted measure of short-term solvency; the higher the ratio, supposedly, the greater the ability of the firm to pay its short-term obligations. However, all of the current assets do not possess the same degree of liquidity. Therefore, the ratio to be used here, liquid assets/current liabilities, omits less marketable or liquid assets from the current assets such as material and supplies. This is a type of quick ratio and it is a more stringent test of liquidity than the current ratio. While the denominator remains the same, the numerator focuses on cash and near

cash coverage of the current liabilities. A low ratio indicates a weak liquidity position.

9. EBIT + depreciation charges/interest charges. The usual interest coverage ratio used in financial ratio analysis is EBIT/interest charges which sometimes is classified as a leverage ratio; supposedly, it measures the extent to which earnings can decline without the resultant inability to meet annual interest charges. However, since depreciation is a significant noncash charge, it is more accurate to add depreciation to EBIT in order to reflect the coverage of interest charges.

10. Cash inflows/fixed charges. The ability of a firm to service long-term obligations is more complex than reflected by an interest coverage ratio. It has been argued that the ability of a firm to service long-term obligations and its liquidity is related to its cash inflow coverage of its fixed charges and that the financial risk associated with leverage should be analyzed on the basis of the firm's ability to service fixed charges. This analysis is perhaps the best way to analyze financial risk, but there is some doubt that the external market for funds analyzes a company in this manner.

The ultimate hazard of running out of cash is the situation where legal contracts are defaulted, bankruptcy occurs and the firm ceases operations. Cash inflows were defined as revenues minus an increase in accounts receivables or plus a decrease in accounts receivables plus other nonoperating inflows of cash. Fixed charges were defined as the sum of interest, lease payments and sinking fund requirements.

Activity and Efficiency. Generally, these ratios measure how efficiently and effectively a firm is using its resources.

11. Overall revenue load factor. The percentage of total revenue ton-miles (passenger plus nonpassenger) to available ton-miles in revenue services. This ratio represents the proportion of the overall capacity that is actually sold and utilized.

12. Revenue passenger load factor. The percentage of revenue passenger-miles to available seat-miles in revenue passenger service. This ratio represents the proportion of aircraft seating capacity that is actually sold and utilized.

13. Sales/total assets. The turnover ratio reflects the relative efficiency with which the firm utilizes its resources in order to generate revenues. Clearly, the smaller the amount of assets necessary to generate a given level of sales, the better.

14. Utilization of aircraft per day. This is an average annual figure in hours and minutes. Presumably, the more intensively the aircraft are utilized, the lower the costs of an airline.

Size and Capacity.

15. Available ton-miles. The aggregate of the products of the aircraft miles flown on each interairport hop multiplied by the available aircraft capacity (tons) for that hop. This represents the traffic carrying capacity offered.

16. Available seat-miles. The aggregate of the products of the aircraft miles flown on each interairport hop multiplied by the number of seats available on that hop. This represents the total passenger carrying capacity offered.

Route Characteristics. They significantly affect operating costs. Overall revenue load factor--see ratio under Activity and Efficiency. Revenue passenger load factor--see ratio under Activity and Efficiency.

17. Overall flight stage length. The average distance covered per aircraft hop in revenue service, from take-off to landing, including both passenger/cargo and all cargo aircraft. This figure is derived by dividing the overall aircraft miles flown in revenue service by the number of overall aircraft revenue departures performed. Supposedly, the average length of flight is extremely critical in determining costs.

18. On-line passenger trip length. Average length of a passenger trip, calculated by dividing the number of revenue passenger-miles in scheduled service by the number of revenue passenger originations in scheduled service. It gives the one-way trip length in terms of one carrier only. Supposedly, if the on-line passenger trip length can be increased, operating costs will be lower.

19. Number of stations/seat-miles. This is a measure of route density and it should significantly affect the economies of an airline.

Investment.

20. Flight equipment/total assets. Many mergers are caused because of a deteriorating financial condition due to a high level of investment in equipment.

21. Net change in operating property and equipment/cash inflows. The preceding measure was static while this measure shows the percentage of cash inflows being used to purchase equipment. If the percentage is very high, a firm may be headed for, or in, financial trouble since it may not have enough cash inflows to make payments on other important items.

Costs.

22. Total costs/available ton-miles. This ratio shows the costs of the airline to its size; hence, it is a measure of economies of scale.

23. Operating costs/available seat-miles. This is a measure of operating costs or economies of the airlines.

24. Operating costs/stage length. This measures the effect of stage length on the costs of operation.

Other.

25. Market price of stock/earnings per share. The literature has indicated that the P/E ratio affects merger decisions; also, this is a measure of the value of each dollar of earnings as decided by the market.

26. Subsidy. The amount of public subsidy to an airline has been very important to the CAB's rulings on merger cases. The higher the subsidy, the more inclined the CAB has been to approve a merger.

Group Pairings

There were nine groups of airlines paired for use in the discriminant analyses. The purpose of the quantitative analysis was to obtain information about mergers by dividing the airlines into several groups representing merger activity in an attempt to find a quantitative difference between the groups. However, some of the group pairings employed in the discriminant analyses were included with the assumption that there would be no difference found between these groups. This was done for two reasons--first, to establish that there was no quantifiable difference that could be found and, second, to use this information to better understand other results of the analysis. Discriminant analysis was used to see if there was a difference between the following groups:

1. The airlines in a merger application which proposed to be the acquiring airlines versus the airlines in a merger application which proposed to be the acquired or the absorbed airlines.

2. Airlines which did not propose mergers versus the airlines which proposed to be the acquiring airlines in merger applications.

3. Airlines which did not propose mergers versus the airlines which proposed to be the acquired airlines in merger applications.

4. Airlines which did not propose mergers versus airlines which proposed mergers.

5. The airlines which proposed to be the acquiring airlines and were approved by the CAB versus the airlines which proposed to be the acquiring airlines and were disapproved by the CAB.

6. The airlines which proposed to be acquired and were approved by the CAB versus the airlines which proposed to be acquired and were disapproved by the CAB.

7. The airlines which proposed to be the acquiring airlines and were disapproved by the board versus the airlines which proposed to be the acquired airlines and were disapproved by the board.

8. The airlines which proposed to be the acquiring airlines and were approved by the CAB versus the airlines which proposed to be the acquired airlines and were approved by the CAB.

9. The mergers approved by the CAB versus the mergers disapproved by the CAB.

CHAPTER V

MULTIPLE DISCRIMINANT ANALYSIS

Introduction

The variables selected in the preceding chapter were used in multiple discriminant analysis (MDA) of nine pairs of groups of airlines representing merger activities. The purpose was to quantify differences between groups.

In this chapter a background discussion of the nature and use of MDA is given and references are supplied for the reader who wishes to pursue the subject in greater depth. Then, the mathematical formation and computational procedure for using MDA are discussed. A test for the assumption of equality of group centroids is given and the classificational procedure employed is explained. Next, MDA is discussed in relation to multicollinearity and factor analysis.

Some preliminary MDA results are discussed in brief, followed by a discussion of how these results were improved. A subsequent set of multiple discriminant analyses are then discussed in detail. How the data were gathered is explained, and the results of the nine pairs of groups of discriminant analyses are given.

The Nature and Use of Multiple Discriminant Analysis

Multiple discriminant analysis (MDA) is a multivariate statistical technique used to classify an observation into one of several a priori

groupings dependent upon the observation's individual characteristics or set of independent variables. The technique is used to classify and make predictions in situations where the dependent variable is non-metric or qualitative. MDA is an alternative to multiple regression when the dependent variable is qualitative.

MDA classifies a set of observations into one of two or more mutually exclusive groups. This classification is done by maximizing the ratio of among-groups variance-covariances to within groups variance-covariances of the independent set of variables for each observation. That is, the technique gives the greatest separation among groups with a given set of independent variables. In addition, the discriminant analysis discloses which variables account for the largest portion of intergroup differences.

MDA was first used in 1935 by M. M. Bernard to classify Egyptian skulls.[1] In 1936 R. A. Fisher used the technique to classify biological specimens.[2] In the earlier years of its use it was applied in the biological and behavior sciences for classification problems.

Discriminant analysis also has been used successfully in the business areas of research. The technique has been used for consumer credit evaluation by D. D. Durand,[3] installment loan evaluation by H. Myers and E. W. Forgy,[4] in the marketing "revolution" as discussed by J. Sheth,[5] and by J. E. Walter to classify firms using price/earnings ratios.[6] Durand used the method for differentiating between good and bad loans in consumer installment lending, and in his discussion, gave a basic discussion of the theory of MDA. Durand noted that the method weighs several credit factors by their relative

importance, allows for interrelationships between factors (inter-correlations or multicollinearity) and allows for maximum group differences.

Edward Altman investigated the predictive ability for bankruptcy of a set of economic and financial ratios employing MDA.[7] An initial sample of sixty-six manufacturing firms were used to develop a discriminant model to differentiate between companies in two groups--bankrupt and nonbankrupt. The results obtained from the initial sample, and the reliability of the discriminant model as a predictive and classifying technique, were impressive. Altman pointed out that the methodology of studies assessing bankruptcy potential were essentially univariate analyses of ratios, and therefore, questionable. On the other hand, MDA selected those ratios which were most important in detecting bankruptcy potential and determined their relative importance in a multivariate analysis. Twenty-two ratios were chosen for the MDA on the basis of their popularity in the literature and their potential relevancy. The best discriminant function contained five ratios and the greater a firm's bankruptcy potential, the lower its discriminant score. In essence, according to a firm's profile, it was assigned to the group it most closely resembled, based on the relative proximity of the firm's score to the various group means. Altman pointed out that the method was explanatory and predictive.

In a later article, he proposed the use of MDA for predicting bankruptcies in the railroad industry by using again financial ratios.[8] He explained that the first study suffered from the potentially serious drawback of the heterogeneous nature of the sample, whereas in the railroad industry, the firms were a homogeneous group. Because of this

homogeneity, it was easier to be more confident that a new firm to be classified would have similar characteristics that were present in the group of firms used to construct the model. Also, he noted that due to ICC reporting requirements, available data were comprehensive, and generally speaking, comparable and uniform. He stated that the primary advantage of MDA in dealing with classification problems is its ability to analyze the entire variable profile of the observations simultaneously with their interrelationships. A univariate study, on the other hand, only can consider the measurements used for group assignments one at a time.

Adelman and Morris used discriminant analysis for selecting underdeveloped countries with immediate development potential.[9] The results showed that 97 percent of the discriminable variance between three groups was represented by a function of four variables selected from the original twenty-nine.

A review of several studies using MDA was done by William Cochran.[10] He examined the performance of the linear discriminant function in twelve examples in the literature. He pointed out that a common use of the linear discriminant function is to classify specimens into one of two populations, with the objective being to minimize the probability of misclassification. A comprehensive discussion of the classification problem under various degrees of knowledge about the populations can be found in a work by T. W. Anderson.[11]
M. M. Tatsouaka, D. G. Morrison and J. G. Bryan gave mathematical derivations of the technique for the general case of n groups.[12]

Frank, Massy and Morrison discussed the nature and causes of sample bias leading to an overstatement of predictive power of

discriminant analysis. Two validation procedures were presented since statistical theory provides no means of adjusting for bias.[13]

Discriminant analysis assumes a multivariate normal distribution of all populations; it also assumes the groups differ in the average value of the measurements or mean vectors.

Multiple Discriminant Analysis Employed in This Research

If the MDA was successful, it would provide two main results in this research. One, it would provide for the separation of groups, and therefore it would be able to classify firms with an accuracy greater than chance; moreover, since preclassification data were used, the model would possess predictive ability in its classifications. Second, it would identify those variables that aid most in classification or possess the most discriminating power in a multivariate context.

The Discriminant Model. As only two groups were used at a time in this research, the discussion of the mathematics of the discriminant model will be confined to the two group case. For two groups, the discriminant function is in the form:

$$Z = v_1x_1 + v_2x_2 + \ldots + v_nx_n \qquad (1)$$

where $v_1, v_2, \ldots, v_n$ are the discriminant coefficients and $x_1, x_2, \ldots, x_n$ are the independent variables. The number of discriminant functions is equal to the smaller of g-1 or n, where g is the number of groups and, n, as above, is the number of independent variables. For two groups, there is only one discriminant function. The discriminant function transforms individual variable values to a single discriminant score, or Z value, which is then used to classify the

object. The MDA computes the discriminant coefficients, v_j, while the independent variables, x_j, are the actual values and j = 1, 2, . . . n.

The discriminant analysis used in this research determined, by an analysis of variance, the linear combinations of variables on the airlines which best discriminated between the groups. The discriminant functions selected successively those variables which accounted for most of the variance between group means, given the other variables already included. Variables were added successively to the discriminant functions until all the variance between group means was exhausted, or until some predetermined point was reached where only a certain percentage of the variance was left unaccounted for.

Discriminant analysis, then, proceeds by first choosing one of the variables which has the greatest variance between its mean value for each group relative to its variance within the groups. It is in this sense the variable "closest" to the one on which the original grouping was based. The next step selects a second variable that, when combined with the first in a linear combination, forms an artificial variable explaining, as before, as much as possible, the variance between group means. The procedure stops when all variables have been included or a certain portion of the total variance has been explained. When formed in this manner, the discriminant function differentiates as much as possible between the groups.

The problem is to maximize, λ, the ratio of the among-groups sum of squares to the within-groups sum of squares, so that the among-groups differences will be large relative to within-group scatter. The purpose is to seek the best discriminant function of the measurement vector x, where x is a deviation from the grand centroid,

$$x_{ki} = X_{ki} - m, \tag{2}$$

where X_{ki} is the dependent vector variable for the ith subject in the kth sample, k = 1, 2, . . . g, where g is the number of populations under study; m is the grand centroid, or vector of total sample means. The desired function is

$$y = v'x. \tag{3}$$

The among-groups sum of squares on the function will be the following quadratic from the matrix of among-groups sums of squares and crossproducts, A:

$$v'Av \tag{4}$$

$$\text{where } A = \sum_{k=1}^{g} N_k (m_k - m)\ (m_k - m)' \tag{5}$$

and m_k is the centroid for sample k; N is the number of subjects in all groups. Similarly, the within-groups sum of squares on the function is the following quadratic from the matrix of pooled within-groups sums of squares and crossproducts of deviation scores,

$$v'Wv \tag{6}$$

$$\text{where } W = \sum_{k=1}^{g} \sum_{i=1}^{N_k} (X_{ki} - m_k)(X_{ki} - m_k)'. \tag{7}$$

The task for the calculus of partial differentiation with respect to the unknown weights in v is to maximize the ratio of these two quadratic forms,

$$\lambda = \left| \frac{v'Av}{v'Wv} \right| \text{ MAX}, \tag{8}$$

subject to the restriction v'v = 1. The maximum value λ and the associated vector of weights, v, are shown by the differential calculus to be the largest eigenvalue and its eigenvector of the equation

$$(W^{-1}A - \lambda I)v = 0, \tag{9}$$

where I is the identity matrix. The solution of (9) is lengthy and will not be shown here, but it yields the vector, v, in (3) or v_i, i = 1, 2, . . . n, in (1).

Equality of Group Centroids. Discriminant analysis assumes that the groups are centered at different locations in the measurement space spanned by the vector variable. The equality of the population centroids, H_1, is tested by Wilks's Lambda. Lambda is a ratio test statistic defined, in the two group case, as

$$\Lambda = \frac{1}{1 + \lambda} \tag{10}$$

or

$$\Lambda = \frac{|W|}{|T|}, \tag{11}$$

where T = A + W.

The null hypothesis is $u_k = u$ for k = 1, 2, . . . g where the best estimator of the common populations centroid, u, is m, the grand centroid. The test of H_1 may be viewed as a test of the discriminating power of the measurement battery for the grouping criterion. The general utility of the test statistic, Λ, depends on the availability of transforms of it that distribute approximately as X^2 and F. Rao's F approximation was used; the F-ratio is

$$\left(\frac{1 - \Lambda}{\Lambda}\right)\left(\frac{N-p-1}{p}\right), \tag{12}$$

where p is the number of variables and the degrees of freedom for the numerator; (N-p-1) represents the degrees of freedom for the denominator and N is the total number of subjects in all groups. The Lambda test of the null hypothesis of the equality of mean vectors assumes that the g group dispersion matrices are based on samples of g

multivariate normal populations with the same dispersion; this assumption is analogous to that of the homogeneity of variance in the univariate F-ratio test of equality of means. As in the univariate case, this assumption is very rarely tested in a multivariate context on the basis that the test of the equality of the mean vectors is fairly robust under departures from its assumptions, and also because computer programs which test the equality of the dispersions or variance-covariance matrices are rare and extremely complicated.

Classification Procedure. The observations were classified according to their Z scores. In equation (1) the Z score was calculated for each observation by substituting the values of the independent variables, x_i, i = 1, 2, . . . n, into the equation; the v_i, i = 1, 2, . . . n, are the calculated discriminant coefficients which remain the same for each observation. The classification boundary for the two group case is simple and is calculated by

$$v_1\bar{X}_1 + v_2\bar{X}_2 + v_3\bar{X}_3 + \ldots + v_n\bar{X}_n = Z_{critical}. \qquad (13)$$

An observation with a score above Z critical was classified in one group while an observation with a Z score below Z critical was classified in the second group. The $\bar{X}_i$ are the grand means of the independent variables.

MDA, Factor Analysis and Multicollinearity. The discriminant model may be interpreted as a special type of factor analysis that extracts orthogonal factors of the measurement battery for the specific task of displaying and capitalizing upon differences among criterion groups. The model derives the components which best separate the groups. The basic input for factor analysis is the correlation matrix.

It can be shown that discriminant analysis is based on the correlation matrix. The purpose of factor analysis is to reduce the amount of data without great loss of information by means of reducing the amount of multicollinearity or correlation among the variables; this is accomplished by producing artificial or imaginary groups of variables. The purpose of discriminant analysis is to account for the maximum variance between groups in order to discriminate maximally among groups. Discriminant analysis has better chance of success when it uses more variable input. It does not matter whether the variables in the discriminant analysis are highly intercorrelated in the sense of producing group separation. Of course, more group separation is possible if the variables are not highly correlated with each other if we are speaking of n variables highly correlated and an equal n number of variables not so intercorrelated. If, however, the n variables are reduced by factor analysis to p variables, $p<n$, the discriminant analysis is adversely affected in its task of providing group separation because there has been some loss of information of the original data because of the use of factor analysis. It is not possible to justify this loss of information on the grounds that the multicollinearity of the variables can be reduced since the discriminant analysis is capable of utilizing all of the information whether the information is highly correlated or not. Therefore, if the purpose of the discriminant analysis in a research is to provide maximum group separation in order to classify firms as correctly as possible, then the loss of information by factor analysis is incorrect.

MDA will select successively those variables which most explain the remaining variance between the groups. It is in this fashion that

MDA considers the multicollinearity of the variables. For example, the first six of twenty variables could account for 90 percent of the variance among groups, and therefore, for 90 percent of the discriminating ability of the function, although it will employ the use of all twenty variables in order to account for 100 percent of the variance among groups which was provided by the data input. If one purpose of the discriminant analysis is to reveal a few number of variables which are capable of discriminating among groups to the extent that it is acceptable to reduce the discriminating ability of the entire test battery, then it is possible to do this after the maximum group separation has been accomplished by using the entire set of data.

In sum, the maximum separation and classification ability of MDA is accomplished by the use of all the data input. Subsequently, it is possible to reduce the number of variables so that a much smaller set can explain group differences, although some loss of discriminating power of the model results.

Preliminary Results of the Multiple Discriminant Analyses. MDA was applied to the nine group pairings which were given in the preceding chapter and which were used for the second multiple discriminant analyses.

MDA is based on group separation provided by the group means of the variables. Firms are then classified on the resemblance of their individual profile of variables to the groups'. It is quite possible than an individual observation will be misclassified although the variable averages provide good group discrimination. The real test of discriminant analysis is its ability to classify observations correctly. If many firms are fairly atypical when compared to the

group centroids, then MDA will unfortunately misclassify a high percentage of firms even though group separation is provided. Apparently, this phenomenon operated with the first set of MDA because of the disappointing classificational ability of the discriminant functions. The classificational power of the discriminant functions, although significant, were all much greater than chance (50 percent) and ranged from 64 percent to 91 percent. This classification test for the various discriminant functions was performed on the observations which constructed the functions. Therefore, a more extreme test of the classificational power of the functions, by using a replication sample or a sample of new firms, could be expected to lower the percentage of correct classifications, but was not used when the decision to try to improve the discriminating power of the functions was made.

Six out of thirteen variables were retained from the first set of MDA and used in the second set of MDA because of their relative importance in the various functions in providing discriminating power. The other variables were examined and it was decided not to include them in the second set of multiple discriminant analyses because of the difficulty of determining their meaning in providing group differences. Other new variables were added in an attempt to provide more discriminating power of the functions.[14]

The first computer program applied to the first set of MDA could not be adapted in order to reduce the functions to a lesser number of variables, thus accounting for a certain percentage of the available discriminating variance between groups. That is, it was possible to determine the relative importance of the variables in the discriminant

functions as compared to the other variables, but it was not possible to determine that five or six variables, for example, accounted for over 90 percent of the variance between groups. Therefore, the functions could not determine an adequate reduced model which would account for most of the variance with fewer variables. The identification of these fewer variables was expected to clarify and simplify group differences for a qualitative explanation of the quantitative differences between groups.

It should be noted that the average values for the ratios and the variables of two yearly figures were introduced to the results of the first set of multiple discriminant analyses in an attempt to improve the results. This approach caused the classificational ability of the functions to decline, although not markedly.

Finally, a second set of MDA were performed on the nine group pairings in an attempt to improve the classificational ability of the functions and facilitate the interpretation of the group differences as displayed by the functions.

Data Collection. The data available from the CAB regarding individual firms are standardized, and therefore, comparable. The data also are very comprehensive, so that the problem was to select a limited number of variables. Data were available on all firms requiring operating authority from the CAB regardless of size; therefore, the data were not biased by firms of large size only (a common problem in much research).

Since the firms in the air transport industry are relatively homogeneous, the prospective results of the analyses were improved. The heterogeneous nature of many firms in samples is a common

difficulty in business research. Also, only horizonal mergers were considered in the hope that this would improve the results of the analyses.

The data collected for each observation were premerger data. This was done in order to establish the predictive ability of the classification powers of the functions. It also corresponds to the premerger identification of the causes of mergers in the qualitative portion of the research.

Data were collected on firms from 1951 through 1971. During that time, there were several significant accounting changes detailed by the CAB. These changes were taken into account and some adjustments to the data were made. This time period was necessary in order to obtain samples of adequate size, although some samples were fairly small. 1951 was chosen as the earliest date for two reasons. It was felt that twenty-one years was too long a test period, however, this was necessary in order to obtain the desired samples. But more important was the fact that comparable data on all variables is provided from 1950 to 1971.

The data for the various groups of firms were collected in the following manner. In any given year, t-1, an airline will potentially belong to one of the groups in the year t. The measurements of the set of variables to be used for each airline was for the year t-1, where t is the year of classification. As was reported above, an average of t-1 and t-2 data was used in the first set of MDA in order to improve group separation, however, this had the opposite effect. The purpose of this approach was to construct predictive models by using data prior to an airline's group classification.

One severe data problem was that over time a firm would belong to different groups, thus affecting the discriminating ability of the functions. The solution to this problem was to provide as much temporal separation as possible without further significantly reducing the samples. The decision was to separate all firms in a group by a minimum of six years. That is, if a firm were in one group in the year t, it would not appear in another group for at least t + 6 years and it also was not in any other group for at least t-6 years.

The groups were of different size but every airline had the same set of quantitative variables. Data are symbolized by X_{ijk}, where i refers to a group, j refers to the observation or airline and k refers to a variable. k equals 26 for all i and j. There were ten unique groups or i and the j varied from group to group. The number of observations available for each group was divided between an original sample which constructed the discriminant functions and a replication sample used to test the ability of the functions to classify new firms not used in the construction of the functions. The sizes of each group of firms is given below along with the division of the available sample between an original (O) and a replication sample (R).

1. Proposed acquirers 48; original (O): 31; replication (R): 17.
2. Proposed acquireds 48; O: 31; R: 17.
3. Nonproposing 76; O: 50; R: 26.
4. Proposed airlines 76; O: 50; R: 26.
5. Proposed acquirers approved 34; O: 22; R: 12.
6. Proposed acquirers disapproved 14; O: 8; R: 6.
7. Proposed acquireds approved 34; O: 22; R: 12.
8. Proposed acquireds disapproved 14; O: 8; R: 6.

9. Airlines approved for mergers 68; O: 46; R: 22.

10. Airlines disapproved for mergers 28; O: 18; R: 10.

The sample of nonproposing airlines was chosen by a random method from the available airlines in this group. It was necessary that these firms satisfy the temporal separation from other groups by plus and minus six years.

Since extreme values for any variable adversely could have affected the results, the ratios and variables which consistently displayed extreme values during the collection process were excluded.

Results Reported For Nine Multiple Discriminant Analyses. There were nine discriminant analyses corresponding to the nine group pairings. For each of the nine MDA, several factors will be reported.

1. Test of group means. The significance of α will be given if the hypothesis that the group means are equal was rejected. The hypothesis was rejected if α was equal to or less than .05. A rejection of the hypothesis indicated that there was a large probability that a real difference existed between the population centroids or mean vectors, and that this difference was not attributable to chance. The acceptance of the hypothesis indicated that there was no real difference between the group centroids and, therefore, there was no basis to proceed with the analysis since the functions produced would not have been able to locate group differences. How the acceptances and rejections relate among one another will be explained after all the MDA have been discussed.

2. Discriminant functions using all variables. Each discriminant analysis was performed using all of the data input. (This procedure was explained earlier.) Basically, this approach allowed for the most

discriminating power of the functions to be produced. In other words, this afforded the model the greatest chance to classify firms correctly. The relative importance of all variables could have been reported from the discriminant functions, but this description of the significance of the variables was deferred for the reduced model where a much easier interpretation of the variables was possible. The classificational ability of the functions was tested in two ways. First, the number of correct and incorrect classifications and their corresponding percentages are given for the original sample of firms whose characteristics constructed the model. Second, a more severe test of the classificational powers of the functions was employed by using a replication sample. Both tests were based on the number of "hits and misses." The second test of the discriminating power was more reliable than calculating the hits and misses of the samples used to form the predictors.

3. Reduced model. After the most discriminating power of the technique was permitted by using all the variables, it was useful to summarize or simplify the functions in order to clarify interpretation of those variables that were important in determining group differences. Each variable in the discriminant analysis was ranked on the basis of the decision rule that it was the variable of the remaining variables which offered the greatest variance between groups, relative to its variance within groups. This procedure was followed until a certain portion of the variance between groups was accounted for which represented a certain portion of the discriminating power of the model, or until a maximum number of variables had been included, whichever came first. For this research, variables were included until

90 percent of the discriminating variance was accounted for or until nine variables had been included. The relative importance of the variables is given by removing the scale factors from the variables. The classificational ability of the reduced model was tested using the same original and replication samples used to test the classificational ability of the full model. This was done to see how much of the discriminating power of the full models was lost by the reduced models which were composed of much fewer variables.

Results of Nine Group Pairings

1) Proposed Acquirers - Proposed Acquireds.

1. Test of means. $\alpha = .01$, so H_1 was rejected.
2. Full model classifications. Classification matrices are given for the original sample and the replication sample.

	Original		87%
	a	b	T
a	26	5	31
b	3	28	31
			62

	Replication		85%
	a	b	T
a	13	4	17
b	1	16	17
			34

a = proposed acquirers b = proposed acquireds T = total

The original sample interpretation is: of the thirty-one airlines in group a (those airlines which proposed to be the acquiring airlines) in year t or the year of classification, twenty-six were classified correctly in group a and five were classified incorrectly in group b (those airlines proposing to be the acquired airlines) by the discriminant model constructed from t-1 data on each airline. Of the thirty-one airlines in group b in year t, the year of classification, three incorrectly were

classified in group a and twenty-eight were classified correctly in group b by the discriminant model constructed from t-1 data on each airline. That is, data were taken on each of the thirty-one airlines in groups a and b in year t-1 to test the classificational or predictive ability of the discriminant function for year t or the year when the actual classification of each airline was a fact. The variable profiles based on t-1 data of the airlines in group a, relative to the variable profiles or the composite quantitative picture for airlines in group b based on t-1 data, produced a discriminant function that correctly classified twenty-six of the thirty-one airlines into group a and twenty-eight of the thirty-one airlines into group b, for the year t or for the year following the data profiles. For example, American Airlines proposed to acquire Eastern Air Lines in 1962. Based on 1961 data, the discriminant function would predict the classification of American and Eastern into groups a and b respectively for 1962. Thirty other examples were used for the full model constructed from the original sample of thirty-one such pairings. The overall classification accuracy for the full model was 87 percent for the original sample of thirty-one airline pairings that constructed the discriminant function.

The interpretation of the results of the replication sample is very similar. The replication sample consisted of airlines that were not included in the original sample which constructed the full model. For example, American and Eastern would not be in the replication sample if they were in the original sample.

This was done as a more extreme test of the classification ability of the full model. Of the seventeen airlines in group a, thirteen were classified correctly in group a and four were classified incorrectly in group b. Of the seventeen airlines in group b, one was classified incorrectly in group a and sixteen were classified correctly in group b. The overall classificational accuracy for the replication sample of seventeen pairings was 85 percent.

3. Reduced model. Eight variables accounted for 95 percent of the discriminating variance between groups. Information on the function and its variables is given in four columns. The first column gives the class of variable to which the variable belongs (see chapter on variable selection); the second column, the specific variable; the third column, the scaled importance of each variable; and the fourth column, the rank of importance of the variable in the function. The numbers immediately preceding

Class	Variable	Scaled Importance	Rank
1. Profitability	1-net income/total assets	34	1
2. Activity and route	12-revenue passenger load factor	32	2
3. Investment	20-flight equipment/total assets	27	3
4. Leverage	5-total debt/equity	25	4
5. Costs	23-operating costs/available seat miles	20	5
6. Size	16-available seat-miles	14	6
7. Liquidity	10-cash inflows/fixed charges	8	7
8. Route characteristics	17-overall flight stage length	3	8

the specific variable in the second column refer to the number of the variable as listed in the chapter on variable selection. The interpretation of the variables in the function is as follows: An airline is mostly likely to be classified in group b (proposed acquireds), if relative to airlines in group a (proposed acquirers), it has a low net income/total asset percentage, a low revenue passenger load factor, a high flight equipment/total assets percentage, a high total debt/equity ratio, high operating costs per available seat-miles, low cash inflows/fixed charges ratio, a short overall flight stage length and if it has fewer available seat-miles.

For example Eastern Air Lines would be classified in group b by the discriminant model if it had enough of the above mentioned quantitative characteristics for airlines in group b relative to the airlines in group a. On the other hand, American Airlines would be classified in group a if it did not possess a variable profile similar enough to the variable profile for group b and, therefore, it had a profile more closely resembling airlines in group a.

The classification matrices for the reduced model are:

	Original		84%
	a	b	T
a	24	7	31
b	3	28	31
			62

	Replication		76%
	a	b	T
a	12	5	17
b	3	14	17
			34

a = proposed acquirers b = proposed acquireds

The full model employed all twenty-six variables in order to establish a variable profile for each airline for its predictive

purpose. The reduced model for this pairing used only eight of the twenty-six variables. This reduced function was then tested for its predictive ability from eight variables. The original sample of thirty-one pairings was the same as the full model. The replication sample consisted of the same seventeen pairings used to test the full model. The interpretation of the classificational matrices for the reduced model is the same as for the full model (see above explanation).

2) Nonproposing Airlines - Proposed Acquirers.[15]

1. Test of Means. $\alpha = .05$ and the null hypothesis that the group centroids were equal was rejected.

2. Full model classifications.

	Original		73%
	a	b	T
a	36	14	50
b	8	23	31
			81

	Replication		65%
	a	b	T
a	17	9	26
b	6	11	17
			43

a = nonproposing airlines b = proposed acquirers

3. Reduced model. Nine variables accounted for 83 percent of the discriminating variance.

Class	Variable	Scaled Importance	Rank
1. Route characteristics	17-overall flight stage length	33	1
2. Investment	21-net change in operating property and equipment/ cash flows	30	2
3. Profitability	1-net income/total assets	28	3

4. Costs	22-total costs/available ton-miles	27	4
5. Leverage	7-total debt/total assets	22	5
6. Other	25-market price of stock/EPS	21	6
7. Route	19-no. of stations/seat-miles	14	7
8. Profitability	4-earnings per share	6	8
9. Liquidity	8-liquid assets/current liabilities	5	9

Firms in group a (nonproposing airlines), relative to firms in group b (proposed acquirers), have short overall flight stage lengths, a greater positive net change in operating property and equipment as a proportion of their cash flows, a lower net income to total assets percentage, higher total costs per available ton-mile, a higher total debt to total asset ratio, lower price-earnings ratios, more stations per seat-mile, less earnings per share and less liquid assets as a proportion of current liabilities.

The classification matrices for the reduced model are:

	Original		63%
	a	b	T
a	31	19	50
b	11	20	31
			81

	Replication		60%
	a	b	T
a	16	10	26
b	7	10	17
			43

a = nonproposing airlines b = proposed acquirers

3) Nonproposing Airlines - Proposed Acquireds.[16]

1. Test of means. $\alpha = .05$ and the null hypothesis was rejected.

2. Full model classifications.

	Original		81%
	a	b	T
a	42	8	50
b	7	24	31
			81

	Replication		74%
	a	b	T
a	21	5	26
b	6	11	17
			43

a = nonproposing airlines b = proposed acquireds

3. Reduced model. Eight variables accounted for 92 percent of the discriminating variance.

Class	Variable	Scaled Importance	Rank
1. Leverage	6-long-term debt/total capitalization	26	1
2. Profitability	2-EBIT/total assets	22	2
3. Investment	21-net change in operating property and equipment/cash flows	20	3
4. Route characteristics	17-overall flight stage length	16	4
5. Other	25-market price of stock/EPS	11	5
6. Costs	22-total costs/available ton-miles	10	6
7. Profitability	4-earnings per share	8	7
8. Activity and route	11-overall revenue load factor	5	8

The airlines in group a (nonproposing airlines), relative to airlines in group b (proposed acquireds), as a group have less long-term debt to total capitalization, more earnings before interest and taxes as a percentage of total assets, less of a positive net change in operating property and equipment as a proportion of cash flows, longer overall flight stage lengths,

higher price-earnings ratios, lower total costs per available ton-mile, greater earnings per share and a higher overall revenue load factor.

The classification matrices are for the reduced model:

	Original		73%
	a	b	T
a	39	11	50
b	11	20	31
			81

	Replication		70%
	a	b	T
a	19	7	26
b	6	11	17
			43

a = nonproposing airlines b = proposed acquireds

4) Nonproposing Airlines - Proposed Airlines.

1. Test of means. The null hypothesis was accepted (no difference was found between the groups). The proposed airlines in this pairing (4) consisted of one-half proposed acquirers and one-half proposed acquireds. It was found that the nonproposing airlines in pairing (2) were not as strong a group as the proposed acquirers, while in pairing (3) above the nonproposing airlines were stronger than the proposed acquireds. Therefore, this group pairing (4) was composed of two other group pairings (2 and 3) whose quantitative differences conflicted when combined to form the pairing (4).

5) Proposed Acquirers Approved - Proposed Acquirers Disapproved.

1. Test of means. The null hypothesis was accepted (no difference was found between the two groups). However, this finding proved helpful. The group, mergers approved, consisted of acquirers and acquired airlines as did the group, mergers disapproved (group pairing (9) below). Since it was shown that there was no difference between proposed acquirers approved and proposed acquirers disapproved (5), it also was likely to be shown there

was no difference between mergers approved and mergers disapproved (9 below) since both these latter groups contained acquirers. This could be true even if a difference was found between proposed acquired airlines approved and proposed acquired airlines disapproved ((6) below). That is, the group pairing, mergers approved and mergers disapproved ((9) below), was composed of the group pairings of (5) and (6). Since no difference was found in (5), the possibility of a group difference in (9) was unlikely even though a group difference was found in (6).

6) Proposed Acquireds Approved - Proposed Acquireds Disapproved.[17]

1. Test of means. $\alpha = .01$ and the null hypothesis was rejected.

2. Full model classifications.

	Original		93%		Replication		89%
	a	b	T		a	b	T
a	20	2	22	a	10	2	12
b	0	8	8	b	0	6	6
			30				18

a = proposed acquireds approved
b = proposed acquireds disapproved

3. Reduced model. Seven variables accounted for 91 percent of the discriminating variance.

Class	Variable	Scaled Importance	Rank
1. Leverage	6-long-term debt/total capitalization	38	1
2. Route characteristics	17-overall flight stage length	35	2
3. Profitability	1-net income/total assets	30	3
4. Costs	23-operating costs/available seat-miles	20	4

5. Size	15-available ton-miles	11	5
6. Other	26-subsidy	8	6
7. Activity and route	11-overall revenue load factor	6	7

The interpretation of the variables in the discriminant function is: as a group, the airlines in a (the proposed acquireds approved), relative to the airlines in b (the proposed acquireds disapproved), displayed a higher long-term debt/total capitalization ratio, a shorter overall flight stage length, a lower return on investment, higher operating costs per available seat-mile, fewer available ton-miles, more subsidy and lower overall revenue load factors.

The classificational ability of the reduced model follows.

	Original		93%		Replication		83%
	a	b	T		a	b	T
a	20	2	22	a	10	2	12
b	0	8	8	b	1	5	6
			30				18

a = proposed acquireds approved
b = proposed acquireds disapproved

7) Proposed Acquirers Disapproved - Proposed Acquireds Disapproved.

1. Test of means. The null hypothesis was accepted (no group difference was found). Notice that the classificational ability of the function for the pair of groups, proposed acquirers approved-proposed acquireds approved (8 below), was greater for both the full model and the reduced model than with the function for the pair of groups, proposed acquirers-proposed acquireds (1 above). This was because the pair of groups showing no difference (7) here, proposed acquirers disapproved-proposed acquireds disapproved (7), were removed from the

proposed acquirers-proposed acquireds group pairing (1) to form the group pairing (8), proposed acquirers approved-proposed acquireds approved. That is, pairing (1) was composed of pairings (7) and (8). No difference was found in pairing (7) even though a difference was found in pairing (1). Therefore, pairing (8) was the reason for the difference in pairing (1), although pairing (7) reduced the discriminating power of pairing (1).

8) Proposed Acquirers Approved - Proposed Acquireds Approved.[18]

1. Test of means. $\alpha = .01$, thus the null hypothesis was rejected.

2. Full model classifications.

	Original		91%		Replication		83%
	a	b	T		a	b	T
a	19	3	22	a	10	2	12
b	1	21	22	b	2	10	12
			44				24

a = proposed acquirers approved
b = proposed acquireds approved

3. Reduced model. Six variables accounted for 94 percent of the discriminating variance.

Class	Variable	Scaled Importance	Rank
1. Profitability	1-net income/total assets	15	1
2. Leverage	5-total debt/equity	13	2
3. Investment	20-flight equipment/total assets	9	3
4. Other	26-subsidy	5	4
5. Profitability	3-net income/stockholder's equity	2	5
6. Size	15-available ton-miles	1	6

Airlines in the group b (proposed acquireds approved), relative to the airlines in the group a (proposed acquirers approved),

displayed a lower rate of return on investment, a higher total debt to equity ratio, more flight equipment as a percentage of total assets, more subsidy, a lower return on stockholder's equity and fewer available ton-miles.

The classification matrices for the reduced model are:

	Original		86%
	a	b	T
a	18	4	22
b	2	20	22
			44

	Replication		79%
	a	b	T
a	9	3	12
b	2	10	12
			24

a = proposed acquirers approved
b = proposed acquireds approved

9) Mergers Approved (Airlines Approved for Mergers) - Mergers Disapproved (Airlines Disapproved for Mergers).

1. Test of means. The null hypothesis was accepted (no difference was found between the groups). There was no difference found between proposed acquirers approved and proposed acquirers disapproved (5) although a difference was found between the proposed acquired airlines approved and the proposed acquired airlines disapproved (6). Since the pairing, mergers approved and mergers disapproved (9), consisted of the total of these two pairings (5) and (6) no difference was found between the groups, mergers approved and mergers disapproved.

Summary

The twenty-six variables which were selected in the preceding chapter were used in this chapter as the basic input to the multiple discriminant analyses (MDA). MDA used group differences to classify observations with an accuracy greater than chance and to identify variables which were significant in detecting group differences. MDA

is "successful" if the hypothesis that there is no difference between groups is rejected.

The variables which were significant in the reduced functions varied from function to function as did their rank. This does not mean the results were unstable. The variables changed from discriminant function to discriminant function, but this occurred only because nine MDA were performed on nine pairings. If only one group pairing had been employed in the research instead of nine, there would have been only one reduced function. The approach employed first provided for the most discriminating power of the functions between groups by using the full function containing all variables, and secondly, the most discriminating variables of the full function were identified by the reduced functions.

If only one discriminant analysis had been performed on one group, only one unique reduced function would have been produced. Since multiple discriminant analyses were performed, other reduced functions were produced which also were unique for their group. One way to minimize the changes in variables from reduced function to reduced function would have been to reduce the original set of variables available for the full model; this approach was considered but was rejected because this would have reduced the classificational ability of the full discriminant functions, and that it was possible to reduce subsequently the full model for within group interpretation of variables.

The relative importance of the variables in the functions in a multivariate context was given; the relative importance of the variables

in a univariate context of disclosing group differences was not given, since no information would have been provided by doing so.

Various sources of sampling and nonsampling errors were discussed and the methods used to limit their influences were given. Potential sources of error must be considered when evaluating the results. Also, the assumption of the equality of group dispersions (variances - covariances) was not tested, as is the usual procedure in business research. This was done mainly since the test of the equality of means is fairly robust under departures from equality of dispersions; that is, the assumption that the group centroids were different would not be accepted easily if the dispersions were not equal.

The interrelationships between several of the groups were discussed and, hence, will not be repeated here.

The results were encouraging. The full functions correctly classified firms of the original samples for 73, 81, 87, 91 and 93 percent of the observations. For the replication samples, the full models correctly classified 65, 74, 83, 85 and 89 percent of the firms in five group pairings. In general, then, the results of the full models were better with the original samples. The results of the reduced models generally were not as good as the full model results, as was expected. For the original samples, the reduced functions correctly classified 63, 73, 84, 86 and 93 percent of the firms. For the replication samples, the reduced functions correctly classified 60, 70, 76, 79 and 83 percent of the firms. Again, the results with the original samples were better than with the replication samples.

A rough ordering of the classificational accuracy of the MDA on the various group-pairings is: (1) proposed acquireds approved-proposed

acquireds disapproved (pairing 6); (2) proposed acquirers approved-proposed acquireds approved (pairing 8); (3) proposed acquirers-proposed acquireds (pairing 1); (4) nonproposing airlines-proposed acquireds (pairing 3); and (5) nonproposing airlines-proposed acquirers (pairing 2). This ranking is not exact because it refers to the classificational ability of the full and the reduced functions for both the original and replication samples for each group pairing, hence, there is some overlap in the classificational accuracy among groups.

The discriminant functions corresponding to these pairs of groups were predictive in their classificational abilities because of the data input which was used to construct the functions. The data were collected for the year prior to any group classification for every observation; if an airline was known to be in a group in the year t, t-1 data were used for its variable profile.

FOOTNOTES

[1]M. M. Bernard, "The Secular Variations of Skull Characters in Four Series of Egyptian Skulls," Annals of Eugenics 6 (1935):352-71.

[2]R. A. Fisher, "The Use of Multiple Measurements in Taxonomic Problems," Annals of Eugenics 6 (1936):179-88.

[3]D. D. Durand, "Risk Elements in Consumer Installment Financing," Studies in Consumer Installment Financing (New York: National Bureau of Economic Research), 1941.

[4]H. Myers and E. W. Forgy, "Development of Numerical Credit Evaluation Systems," Journal of American Statistical Association 50 (September 1963):797-806.

[5]Jagdish Sheth, "The Multivariate Revolution in Marketing Research," Journal of Marketing, Vol. 35, January 1971.

[6]J. E. Walter, "A Discriminant Function for Earnings-Price Ratios of Large Industrial Corporations," Review of Economics and Statistics, February 1959, pp. 44-52.

[7]Edward Altman, "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," Journal of Finance 23 (September 1968):589-609.

[8]Edward Altman, "Railroad Bankruptcy Propensity," Journal of Finance, May 1971, pp. 333-45.

[9]Irma Adelman and Cynthia Morris, "Performance Criteria for Evaluating Economic Development Potential: An Operational Approach," Quarterly Journal of Economics 82 (May 1968):260-80.

[10]William Cochran, "On the Performance of the Linear Discriminant Function," Technometrics, May 1964, pp. 179-90.

[11]T. W. Anderson. An Introduction to Multivariate Statistical Analysis, (New York: John Wiley and Sons, 1958).

[12]M. M. Tatsouaka and D. V. Tiedeman, "Discriminant Analysis," Review of Educational Research. (Washington, D.C.: American Educational Research Association, 1954).

J. G. Bryan, "The Generalized Discriminant Function: Mathematical Foundation and Computional Routine," Harvard Educational Review, no. 2, pp. 90-96.

D. G. Morrison, "On the Interpretation of Discriminant Analysis," Journal of Marketing Research 6 (May 1969):156-63.

[13]Frank, Ronald; Massy, William and Morrison, Donald. "Bias in Multiple Discriminant Analysis," Journal of Marketing Research, August 1965, pp. 250-58.

[14]All the variables used were discussed in the preceding chapter.

[15]For a detailed explanation of what the results mean, see pairing (1).

[16]For an explanation on how to interpret the results see pairing (1).

[17]See pairing (1) for an explanation on how to interpret the results reported.

[18]See pairing (1) for a detailed explanation of the reported results.

CHAPTER VI

SUMMARY AND SIGNIFICANCE OF THE RESEARCH

This research was organized into two parts. One part examined the reasons for the airlines to merge and the reasons for the CAB in approving or disapproving a merger application. The second half of the study used a statistical technique, multiple discriminant analysis, to quantitatively identify airline group differences concerning merger activity. The two methods of research dealt with the same goal of divulging merger information about airlines. The first approach was qualitative in nature; it examined the qualitative reasons of the airlines to merge and the reasons of the CAB to approve or to disapprove such merger proposals. The second approach was quantitative in nature; statistically it examined the group differences of the airlines concerning their merger activity.

Reasons of the airlines to merge have been the desire to achieve economies of scale, to improve management, to take advantage of a bargain price, to reduce business and financial risk, to affect tax savings, to grow rapidly, to improve service and increase demand, to increase monopoly power and to correct or relieve operating weaknesses and financial difficulties.

The benefits that the board expected from mergers have been economies of scale, replacing inefficient management, reduction in business and financial risk, tax savings, improved service and increases

in demand. Typically, the board has been responsive to these expected benefits of mergers only when it has considered a merger desirable in order to improve the operating characteristics and the financial condition of a carrier. The board has been reluctant to reduce significantly competition by mergers. In each merger that the CAB has approved, it has found the price to be reasonable and the labor protective provisions satisfactory. In all but two approved mergers, the board has found that the merger would not create a monopoly, jeopardize another carrier or cause significant diversion of traffic from other carriers.

Multiple discriminant analysis was employed to detect group differences, to classify firms and to identify variables important in uncovering group differences. Discriminant analysis was used to detect any differences between the following groups based upon the variable input, and, if so, what variables detected this difference between the groups.[1]

1) The airlines which proposed to be the acquired or the absorbed airlines relative to the airlines which proposed to be the acquiring airlines in merger applications exhibited unfavorable financial, operating and route characteristics and were of a smaller size.

2) The airlines which did not propose mergers relative to the airlines which proposed to be the acquiring airlines in merger applications exhibited unfavorable financial, operating and route characteristics.

3) The airlines which did not propose mergers relative to the airlines which proposed to be the acquired airlines in merger applications exhibited more favorable financial, operating and route characteristics.

4) No difference was found between those airlines which did not propose mergers and the airlines which did.

5) No difference was found between the airlines which proposed to be the acquiring airlines and were approved by the CAB and the airlines which proposed to be the acquiring airlines and were disapproved by the CAB.

6) The airlines which proposed to be acquired and were approved by the CAB relative to the airlines which proposed to be acquired and were disapproved by the CAB exhibited unfavorable financial, operating and route characteristics, were smaller in size and were receiving more subsidy from the government.

7) No difference was found between the airlines which proposed to be the acquiring airlines and were disapproved by the board and the airlines which proposed to be the acquired airlines and were disapproved by the board.

8) The airlines which proposed to be the acquiring airlines and were approved by the CAB relative to the airlines which proposed to be the acquired airlines and were approved by the CAB exhibited more favorable financial and operating characteristics, were larger in size and were receiving less subsidy from the government.

9) No difference was found between the airlines approved for mergers by the CAB and the airlines which were disapproved.

The quantitative results, therefore, indicated several conclusions. The airlines proposing to be the acquiring airlines exhibited stronger financial, operating and route characteristics than those airlines not proposing mergers and those airlines proposing to be absorbed. In turn, the nonproposing airlines showed more favorable

quantitative characteristics than the airlines proposing to be acquired. The CAB has approved most mergers when the acquired airline has shown unfavorable financial, operating and route characteristics, when they were of smaller size and when they had been receiving more subsidy from the government relative to the airlines proposing to be acquired it has disapproved for merger. In most mergers the CAB has approved the acquiring airline has exhibited a stronger quantitative profile than the acquired airline. On the other hand, the board has shown no tendency to distinguish between the characteristics of the acquiring airlines approved for mergers and those disapproved. Also, the airlines proposing to be acquired which were disapproved by the board were mostly not different than the airlines proposing to be the acquiring airlines and were disapproved.

The main limitation of the qualitative approach was that it was difficult to establish basic relationships in a complex situation. It was necessary to interpret the available pertinent information to identify the reasons for mergers. However, there were very few merger cases where the reasons of the airlines and the CAB had to be inferred from very limited information. The main limitation of the quantitative approach was due to the necessity of attempting to reduce complicated merger motives and CAB action to quantitative surrogates.

Mergers have a great actual and potential impact on the structure of an industry. In order that antitrust and regulatory statutes can be applied judiciously it is first necessary to have a sound understanding of the motives which bring two firms to a merger decision. In addition, in order to be able to review the desirability of regulatory policies on mergers, it is necessary to have a basic knowledge of the

reasons why the regulators make their decisions on merger proposals. The structure of an industry is fundamental in explaining the conduct and performance of an industry. Therefore, it seemed appropriate to enrich the knowledge on a major determinant of structure, namely mergers. The research was specific to the air transport industry for several reasons--author interest, the significance of the industry in the economy and the hope that a restricted scope would provide understandable and specifically applicable results.

The air transport industry is an excellent area for merger research or for that matter, other economic research. Documents, reports and data are readily available. The firms in the industry are very homogeneous; data is comprehensive and comparable. It should be possible and, indeed, useful to investigate other aspects of mergers in this industry, such as a capital budgeting approach to the merger decision or a post-merger evaluation of the effects of mergers on the conduct and performance of the individual firms and the industry.

FOOTNOTES

[1]The listing of the group-pairings is identical to their order for the results of chapter five. For a more detailed explanation of the results see chapter five.

APPENDIX I

APPENDIX I

LEGAL STANDARDS FOR MERGERS

The Federal Aviation Act of 1958[1] authorizes the Civil Aeronautics Board[2] to approve or disapprove any merger[3] between air carriers.[4] Section 408 of this act specifically confers the board's power over mergers.[5] Section 408(a) (1) provides that it shall be unlawful unless approved by order of the board

> for two or more air carriers, or for any air carrier and any other common carrier or any person engaged in any other phase of aeronautics, to consolidate or merge their properties, or any part thereof, into one person for the ownership, management, or operation of the properties theretofore in separate ownerships.[6]

The board also pointed out that

> jurisdiction over merger transactions may also be asserted under section 408(a) (1) which, among other things, requires Board approval for the purchase of a substantial part of the properties of one carrier by another and under section 408(a) (5) which, among other things, requires Board approval for any air carrier to acquire control of another in any manner whatsoever.[7]

Section 408(b) provides that:

> Any person seeking approval of a consolidation, merger, purchase, lease, operating contract, or acquisition of control, specified in subsection (a) of this section, shall present an application to the Board, and thereupon the Board shall notify the persons involved in the consolidation, merger, purchase, lease, operating contract, or acquisition of control, and other persons known to have a substantial interest in the proceeding, of the time and place of a public hearing. Unless, after such hearing, the Board finds that the consolidation, merger, purchase, lease, operating contract, or acquisition of control will not be consistent with the public interest or that the

> conditions of this section will not be fulfilled, it shall by order, approve such consolidation, merger, purchase, lease, operating contract, or acquisition of control, upon such terms and conditions as it shall find to be just and reasonable and with such modifications as it may prescribe: Provided, that the Board shall not approve any consolidation, merger, purchase, lease, operating contract, or acquisition of control which would result in creating a monopoly or monopolies and thereby restrain competition or jeopardize another air carrier not a party to the consolidation, merger, purchase, lease, operating contract, or acquisition of control.[8]

Under section 408(b), then, an application for a consolidation or merger is to be approved, unless it is found that the proposed consolidation or merger will not be consistent with the public interest, or that it will result in creating a monopoly and thereby restrain competition or jeopardize another air carrier not a party to the consolidation or merger.[9] Section 408(b) also requires the filing of an application by parties seeking relief from the restrictions of section 408(a), and a subsequent hearing upon such an application.

Section 408(b) directs the board to determine if a proposed merger is inconsistent with the public interest. The board has held on many occasions that the standards for determining the public interest are enumerated in section 102.[10] In the first merger case under regulation the Civil Aeronautics Authority pointed out that:

> "Public Interest" as thus used in the act is not a mere general reference to public welfare, but has a direct relation to definite statutory objectives. Thus, section 2 of the act directs the authority to consider certain specific objectives as being in the public interest.[11]

Section 102 states:

> In the exercise and performance of its powers and duties under this act, the Board shall consider the following, among other things, as being in the public interest, and in accordance with the public convenience and necessity:

> (a) The encouragement and development of an air transportation system properly adapted to the present and future needs of the foreign and domestic commerce of the United States, of the Postal Service, and of the national defense;
> (b) The regulation of air transportation in such manner as to recognize and preserve the inherent advantages of, assure the highest degree of safety in, and foster sound economic conditions in, such transportation, and to improve the relations between, and coordinate transportation by, air carriers;
> (c) The promotion of adequate, economical, and efficient service by air carriers at reasonable charges, without unjust discriminations, undue preferences or advantages, or unfair or destructive competitive practices;
> (d) Competition to the extent necessary to assure the sound development of an air-transportation system properly adapted to the needs of the foreign and domestic commerce of the United States, of the Postal Service, and of the national defense;
> (e) The promotion of safety in air commerce; and
> (f) The promotion, encouragement, and development of civil aeronautics.[12]

In each case the evidence is examined in light of the criteria given by the act in Section 102. In the Southwest - West Coast Merger Case it was stated that

> the Board has frequently held in proceedings of this nature, the public interest standard referred to in section 408 of the Act must be interpreted in the light of the statutory objectives laid down in section 2. Therefore, to be consistent with the public interest the proposed merger must be a step toward effectuating the aims and objectives of the Act.[13]

In the same case the board merely added:

> The statutory purposes of the Act are well known and fully understood and need not be restated in detail here. Suffice it to say that the underlying objective of these purposes is the sound development of an adequate, economical, and efficient air transportation system, properly adopted to the present and future needs of the foreign and domestic commerce of the United States, of the Postal Service, and of the national defense.[14]

Section 401(h)[15] of the FAA provides that "no certificate may be transferred unless such transfer is approved by the board as being

consistent with the public interest."[16] Section 401(h) has applied to all consolidation and merger applications since all applications have included the request to transfer the certificate of public convenience and necessity of the acquired airline to the surviving airline.

Section 408(b) requires only the negative finding that the proposed merger will not be inconsistent with the public interest for the board to approve a merger. Approval of the transfer of a certificate of public convenience and necessity under section 401(h) requires as affirmative finding that the proposed transfer will be consistent with the public interest. Thus the public interest is the primary consideration under each of the sections. In connection with the negative versus affirmative required finding the board said:

> Under our interpretation of these sections, in accordance with well-established rules of construction, the distinction between the affirmative and the negative findings is an unimportant one for the purposes of this decision since the public interest is the primary consideration of either of them.[17]

If the proposed merger involves an air carrier which is authorized to engage in foreign air transportation, it is also subject to the approval of the president under section 801.[18] Section 414[19] immunizes an airline merger approved by the board from prosecution under the antitrust laws.[20]

The broad and general statutory principles in effect allow the board to exercise great discretion in approving or disapproving mergers. In addition, section 408(b) allows the board to attach such terms and conditions to a proposed merger as it finds just and reasonable.

According to a Senate Commerce Committee report, the statute was intended by Congress to "favor mergers, where possible."[21] Airline

mergers appear to be judged by the policies of the antitrust laws only to the extent that they are assumed to be embodied in the public interest criteria of section 102.[22] In McLean Trucking Co. v. United States,[23] the Supreme Court upheld the antitrust immunity of the Interstate Commerce Act, which contains a provision comparable to section 414 of the FAA. The Court held that the commission was not bound to apply the antitrust laws rigorously to a merger of motor carriers, and, rather, the commission in each case was to give "strict regard" to the antitrust laws and then to strike an appropriate balance between competition and the other objectives of the act. The board stated in the Local Cartage Agreement Case that:

> Where an agreement has among its significant aspects elements which are plainly repugnant to established antitrust principles, approval should not be granted unless there is a clear showing that the agreement is required by a serious transportation need or in order to secure important public benefits.[24]

Although the board has never disapproved a merger on the explicit grounds that it would create a monopoly it has stated that a merger would not be consistent with the public interest if it would give the merger airline control of air transportation greatly in excess of that possessed by competitors, or would endanger a reasonably balanced system of air transportation in every section of the country.[25] In American Airlines, Inc., Acquisition of Control of Mid-Continent Airlines, Inc.[26] the board again stressed the competitive factor in determining the public interest.[27] It was concerned with the competitive advantage inherent in sheer size and geographical scope of operations and also the potential attendant economic injuries to rival carriers.

All decisions by the board are subject to judicial review except mergers involving a foreign air carrier or foreign routes subject to approval by the president.[28] The Supreme Court has held in Chicago So. Airlines, Inc. v. Waterman S. S. Corp.[29] that presidential action under section 801 is not subject to review by the courts. Any other order by the board is reviewable by either the federal court of appeals for the circuit where the petitioner resides or has his principal place of business or the Court of Appeals for the District of Columbia.[30] Section 1006(e) directs that board findings shall be conclusive "if supported by substantial evidence."[31] However, the courts have often stated that the board must not act arbitrarily.[32] The question on appeal is whether there is substantial evidence to support findings of fact and whether the inferences drawn are reasonable. Reviewing courts, however, have been reluctant to substitute their judgment for that of the agency.

Other influences on the board's actions, although indirect, include congressional pressure, the Justice Department's role as an intervener and additional interveners appearing before the board. But as an independent agency, the board is delegated by Congress to exercise considerable discretion in deciding merger cases; this power has been upheld by the courts. Moreover, the board is empowered to attach terms and conditions to an approved merger as it sees fit.

FOOTNOTES

[1]The Civil Aeronautics Act of 1938 [52 Stat. 973 (1938); 49 U.S.C. 1301-1542 (1938)] was the predecessor statute governing mergers and was adopted, except for minor changes, as the Federal Aviation Act of 1958 [72 Stat. 731; 49 U.S.C. 1301 - 1542 (Supp. 1958); hereafter referred to and cited as FAA]. The sections of the FAA of 1958 concerning mergers are identical to the sections of the Civil Aeronautics Act of 1938 except section 2 of 1938 is section 102 of 1958 and section 401(i) of 1938 is section 401(h) of 1958.

[2]Originally the Civil Aeronautics Authority until 1940.

[3]The term merger will include consolidation herein.

[4]Air Carrier is defined to mean "any citizen of the United States who undertakes, whether directly or indirectly or by a lease or any other arrangement, to engage in air transportation" [FAA 101 (3), 49 U.S.C. 1301 (3) (1958)].

[5]FAA 408(a), (b), 49 U.S.C. 1378(a), (b) (1958).

[6]72 Stat. 767 (1958), 49 U.S.C. 1378(a) (1958).

[7]14 CAB 356, 360 (1951).

[8]52 Stat. 1001 (1938); 49 U.S.C. 1378(b) (Supp. 1958).

[9]The board has interpreted monopoly as a particular degree of control of air transportation rather than a general tendency to stifle competition and control prices. See 1 CAA 739 (1940). It has been suggested that the board has read the monopoly proviso out of the statute. See the following comment: "Merger and Monopoly in Domestic Aviation," Columbia Law Review 62 (May 1962):851-83.

[10]72 Stat. 740 (1958), 49 U.S.C. 1302 (1958). Section 102 of the FAA of 1958 was section 2 of the Civil Aeronautics Act of 1938; 52 Stat. 980 (1938); 49 U.S.C. 1302.

[11]1 CAA 739, 741 (1940). For other references to the criteria of public interest provided by section 102, see 2 CAB 1, 4 (1940); 2 CAB 503, 506 (1940); 4 CAB 654, 656 (1944); 4 CAB 680, 681 (1944); 7 CAB 365, 371-72 (1946).

[12]72 Stat. 740 (1958), 49 U.S.C. 1302 (1958).

[13]14 CAB 356, 361 (1951).

[14]Ibid., note 4.

[15]Section 401(i) in the 1938 act is section 401(h) in FAA (1958).

[16]FAA 401(h) (1958); 49 U.S.C. 1371(h) (1958).

[17]4 CAB 680, 681 (1944). This concept was affirmed in 16 CAB 647, 685-86 (1952).

[18]FAA 801, 49 U.S.C. 1461 (1958).

[19]72 Stat. 770 (1958); 49 U.S.C. 1384 (1958).

[20]The Justice Department has intervened in proceedings although the board considers them and any other intervener with a position to state. Also the Justice Department has appealed rulings of the board to the courts. The Supreme Court has generally held that the regulatory agency rather than the Justice Department has the final word.

[21]U. S. Senate, Report No. 445, 87th Cong., 1st sess., 701 (1961).

[22]G. E. Hale and R. D. Hale, "Competition or Control: Air Carriers," University of Pennsylvania Law Review 109 (January 1961):311-60; G. E. Hale and R. D. Hale, "Competition or Control VI: Application of Antitrust Laws to Regulated Industries," ibid. 111 (November 1962): 46-59; Louis B. Schwartz, "Legal Restriction of Competition in the Regulated Industries: An Abdication of Judicial Responsibility," Harvard Law Review 67 (January 1954):436-75.

[23]321 U.S. 67 (1944).

[24]15 CAB 850, 852 (1952).

[25]1 CAA 739, 749-50 (1940).

[26]7 CAB 365 (1946).

[27]Ibid., 378-79.

[28]FAA 1006(a), 49 U.S.C. 1486(a) (1958).

[29]333 U.S. 103 (1948).

[30]FAA 1006(b), 49 U.S.C. 1486(b) (1958).

[31]FAA 1006(e), 49 U.S.C. 1486(e) (1958).

[32]North Central Airlines v. CAB, 265 F. 2d 581, 584-85 (D.C. Cir.), cert. denied, 360 U.S. 903 (1959); Consolidated Flower Shipment v. CAB, 213 F. 2d 814 (9th Cir. 1954).

SELECTED BIBLIOGRAPHY

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Books

Alberts, William W. and Segall, Joel E. (ed) The Corporate Merger, Chicago: University of Chicago Press, 1966.

Anderson, T. W. An Introduction to Multivariate Statistical Analysis, New York: John Wiley and Sons, 1958.

Archer, Stephen H. and D'Ambrosio, Charles A. Business Finance: Theory and Management, New York: Macmillan Company, 1966.

Caves, Richard. Air Transport and its Regulators, Cambridge, Mass.: Harvard University Press, 1962.

Frederick, John. Commercial Air Transportation, Homewood, Ill.: Richard Irwin, 1955, 4th edition.

Harvey, John and Newgarden, Albert. Management Guides to Mergers and Acquisitions, New York: John Wiley and Sons, 1969.

Hutchinson, G. S. (ed.) The Business of Acquisitions and Mergers, New York: Presidents Publishing House, 1968.

Mace, Myles and Montgomery, George. Management Problems of Corporate Acquisition, Boston: Harvard University Press, 1962.

Reid, Samuel R. Mergers, Managers and the Economy, New York: McGraw-Hill, 1968.

Straszheim, Mahlon. The International Airline Industry, Washington, D.C.: The Brookings Institution, 1969.

Van Horne, James C. Financial Management and Policy, Englewood Cliffs: Prentice-Hall, 1968.

Weston, J. Fred and Brigham, Eugene F. Managerial Finance, New York: Holt, Rinehart and Winston, 1969.

Wheatcroft, Stephen. Air Transport Policy, London: Michael Joseph, 1964.

Articles and Periodicals

Adelman, Irma and Morris, Cynthia. "Performance Criteria for Evaluating Economic Development Potential: An Operational Approach," Quarterly Journal of Economics, LXXXII (May 1968) 260-280.

Alberts, William W. "The Profitability of Growth by Merger," in The Corporate Merger, edited by William W. Alberts and Joel E. Segall, Chicago: University of Chicago Press, 1966, 235-287.

Altman, Edward. "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," Journal of Finance, XXIII (September 1968) 589-609.

Altman, Edward. "Railroad Bankruptcy Propensity," Journal of Finance (May 1971) 333-345.

Bryan, J. G. "The Generalized Discriminant Function: Mathematical Foundation and Computational Routine," Harvard Educational Review, No. 2 (Spring 1951) 90-96.

Butters, Keith and Lintner, John. "Tax and Non-tax Motivations for Mergers," in Elements of Financial Administration, edited by John O'Donnell and Milton Goldberg, Columbus, Ohio: Charles Merrill Books, 1962, 629-651.

Cochran, William. "On the Performance of the Linear Discriminant Function," Technometrics (May 1964) 179-190.

Durand, D. D. "Risk Elements in Consumer Installment Financing," Studies in Consumer Installment Financing, New York: National Bureau of Economic Research, 1941.

Federal Trade Commission. Economic Report on Corporate Mergers, Hearings on Antitrust and Monopoly, Committee of the Judiciary, US Senate, 91st Congress, 1st sess., part 8A, UPSGO, 1969.

Frank, Ronald; Massy, William and Morrison, Donald. "Bias in Multiple Discriminant Analysis," Journal of Marketing Research (August 1965) 250-258.

Gort, Michael. "An Economic Disturbance Theory of Mergers," Quarterly Journal of Economics (November 1969) 624-642.

Koontz, H. D. "Economic and Managerial Factors Underlying Subsidy Needs of Domestic Trunk Line Air Carriers," Journal of Air Law and Commerce 18, No. 2 (Spring 1951) 127-156.

Lewellen, Wilbur. "A Pure Financial Rationale for Conglomerate Mergers," Journal of Finance, XXVI (May 1971) 521-537.

Lintner, John. "Expectations, Merger and Equilibrium in Purely Competitive Securities Markets," American Economic Review LXI, No. 2 (May 1971) 109-114.

Marion, David. "The American-Eastern Application: Crucial Test of CAB Merger Policy," University of Pennsylvania Law Review (December 1962) 199.

McCarthy, George D. "Premeditated Merger," in Foundations for Financial Management, edited by James Van Horne, Homewood, Ill.: Richard Irwin, 1966, 565-580.

McKenna, William E. "Merger, an Art and a Science," in Readings in Finance, edited by Harold Wolf and Lee Richardson, New York: Appleton-Century-Crofts, 1966, 349-350.

Morrison, D. G. "On the Interpretation of Discriminant Analysis," Journal of Marketing Research VI (May 1969) 156-163.

Myers, H. and Forgy, E. W. "Development of Numerical Credit Evaluation Systems," Journal of American Statistical Association, L (September 1963) 797-806.

Proctor, Jesse W. and Duncan, Julius. "A Regression Analysis of Airline Costs," Journal of Air Law and Commerce, XXI (Summer 1954) 282-292.

Schwartz, Samuel. "Merger Analysis as a Capital Budgeting Problem," in The Corporate Merger, 139-150.

Walter, J. E. "A Discriminant Function for Earnings-Price Ratios of Large Industrial Corporations," Review of Economics and Statistics, (February 1959) 44-52.

Weiss, Leonard. "An Evaluation of Mergers in Six Industries," Review of Economics and Statistics (May 1965) 172-181.