Financial ratio patterns in the U.S. defense industry

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IN THE
U.S. DEFENSE INDUSTRY

by

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FINANCIAL RATIO PATTERNS IN THE U.S. DEFENSE INDUSTRY

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ABSTRACT

There have been dramatic political and economic changes affecting the United States defense industry during the past decade (1983-1992). The purpose of this research was to determine the effect of these changes on financial ratio patterns of defense industry firms. The research sample included thirty-eight defense industry firms selected from the top hundred Department of Defense contractors. Fifteen financial ratios, representing four broad categories, were examined for sample firms for a ten year period. Statistical and visual analyses were conducted for each ratio in order to investigate industry financial ratio patterns. The analyses provided significant evidence for the following broad conclusions concerning financial ratio patterns during the ten year period: profitability had declined and risk increased in the defense industry; recent years have shown increasing dispersion (less uniformity) in financial condition across defense industry firms; there was some indication that ratios in the most recent years have become more stable suggesting that the period of greatest turmoil for the industry may be passing.

TABLE OF CONTENTS

I. INTRODUCTION

A. BACKGROUND

The defense industry differs from other industry sectors in such matters as the need for large investments in plant and equipment, the cyclical nature of the business, the nature of the customers, the nature of the products being sold, and the use of computers and other aspects of high technology. The major customer for most of the firms is the United States government. This setting is a monopsony because the federal government has some monopoly powers, given that it is the primary buyer in this market. Among the various implications of this, probably the most important is that the industry is dependant on the federal government's willingness and capacity to buy product. [Ref. 12, p.54]

In recent years the defense industry in the U.S. has experienced significant turmoil. Four forces have converged to change the environment in which defense industry firms operate.

First has been the collapse of communism and breakup of the former USSR. The world witnessed a new chapter in history during the past decade. A number of countries in Eastern Europe were becoming more democratic and it appears that they are be moving toward more capitalistic societies.[Ref. 12, p.55] Old enemies were becoming new friends. As a result of these profound changes, the cold war between the United States and the Soviet Union ended. This has led to a shift in defense strategy. The U.S. will not keep as large a force as it used to be in the Europe. This could easily lead to less business for the defense firms. [Ref. 12, p.55]

Second has been the reduction in the defense spending portion of the federal budget. Increasing budget deficit pressure forced federal government to be more sensitive to government spending. Congress is trying to reduce the budget,

and the defense component of the budget is up for debate. The implication of the decreasing defense budget is fewer orders for the defense industry and thus fewer profits.

Third has been the recession and subsequent slow growth experienced during the early 1990s. The economy fell into recession beginning in mid-1990. [Ref. 23, p.vi]

Fourth has been the increased competitive pressures resulting in the restructuring of much of U.S. industry. Increasing bargaining power of buyers in the defense industry made the competition severe among the defense firms.

B. OBJECTIVE

The premise of this study is that the convergence of these factors may have resulted in a shift in the financial structure of firms in the defense industry. The broad purpose of this study is to document that shift as reflected in the financial ratios of defense industry firms. The intent is to provide a description and analysis of defense industry financial ratio patterns that may serve as a foundation for financial analyses within the defense industry and for the prediction of future financial condition of defense industry firms.

The broad objective of this research is to examine the financial ratio patterns exhibited by defense industry firms. Related objectives include describing present ratio patterns, determining whether ratio patterns (in contrast to ratio values) have changed materially in recent years, and suggesting how knowledge of ratio patterns can be exploited in conducting financial analysis of defense industry firms.

C. RESEARCH QUESTIONS

1. Primary research question

What patterns exist for financial ratios of firms in the defense industry and what changes have resulted as the industry has reacted to the economic and political changes

occurring during the 1990s?

2. Secondary research questions

1. What levels exist for individual financial ratios?
2. How much dispersion exists across the industry?
3. How much year-to-year variability exists for individual ratios?
4. Have the level, the dispersion and variability of ratios changed during the 1990s?
5. Is there evidence of permanent change in the value for individual ratios or is there evidence that "equilibrating" forces are at work to return ratio values to "normal" values.

D. SUMMARY OF FINDINGS

The purpose of the research was to determine the financial ratio patterns of the United States defense industry during the past decade (1983-1992.) Fifteen financial ratios were calculated from the thirty-eight defense industry firms' financial statements. Statistical and visual analyses were used for each ratio in order to investigate industry financial ratio patterns.

The analyses provided significant evidence for the following broad conclusions during the ten year test period: profitability had declined and risk increased in the industry; recent years have shown increasing dispersion (less uniformity) in financial condition across defense industry firms; there was some indication that ratios in the most recent years have become more stable suggesting that the period of greatest turmoil for the industry may be passing.

E. ORGANIZATION OF STUDY

Chapter II discusses the background, and the related literature review. In the background section, the evolution of the defense budget and defense industry are examined.

Articles discussing ratio patterns are discussed in the latter section.

Chapter III addresses the methodology of the study including sample selection, data collection, ratios chosen for testing, the structure of the analysis and the statistical tests.

Chapter IV describes the analysis of profitability ratios. Four individual ratios were examined in order to gain insight into the broad picture of industry profitability. These were the gross margin, operating margin, return on sales and return on assets ratios.

Chapter V describes the analysis of industry efficiency. Inventory turnover, asset turnover, turnover of working capital, and fixed asset turnover ratios were examined.

Chapter VI describes the analysis of liquidity ratios. Industry liquidity was explored by focusing on three ratios: the current ratio, quick ratio, and cash ratio.

Chapter VII describes the analysis of leverage ratios reflecting the capital structure of firms in the industry. Equity to debt, equity to asset, debt ratio, and retained earnings to asset ratios were analyzed.

Chapter VIII provides the conclusions of the research, and recommendations for further studies.

II. BACKGROUND AND LITERATURE REVIEW

A. INTRODUCTION

In this chapter the historical evolution of the federal defense budget, the nature of the defense industry, and literature related with this study are discussed. It begins with the discussion of the historical evolution of the federal defense budget, the main forces behind the defense budget reduction and the effects on the defense industry. In a later section, articles related to this study are discussed.

B. BACKGROUND

1. Changing World

The dramatic developments of the past couple of years have filled many with hope and optimism, as the dangerous and costly elements of the Cold War have been replaced with negotiation, cooperation, and expectations that defense funds might be diverted to other social priorities.[Ref. 21, p.1]

For 40 years, U.S. defense requirements have been dominated by the objective of defending Western Europe and deterring Soviet threats there and elsewhere (including nuclear threats to our homeland). The Soviet threat, at least in its historical embodiment as a cohesive bloc of advanced multinational forces and capabilities, is severely diminished. A sudden massive mobilization of offensive firepower close to the German border is no longer conceivable. There was enough significant evidence for the United States to consign the Cold War to the history books.[Ref. 21, p.1]

It is reasonable to conclude that the geopolitical environment will continue to contain many sources of instability and threats. Many of the threats will have more than just a military dimension. The U.S. will need effective diplomatic and economic instruments as well as creative capabilities for orchestrating their use in combination with military force. [Ref. 21, p.6]

2. Defense Budget

In response to the end of Cold War, the United States has undertaken a major reduction in resources committed to national defense. Department of Defense procurement outlays are expected to decline 29% in real terms between 1992 and 1997. This decline follows the 24% decrease that occurred from 1987 to 1992.[Ref. 9, p.iii] Total DoD procurement dollars between 1983 and 1992 are plotted in Exhibit 2-1 (Source: Defense Almanacs, publication of DoD).

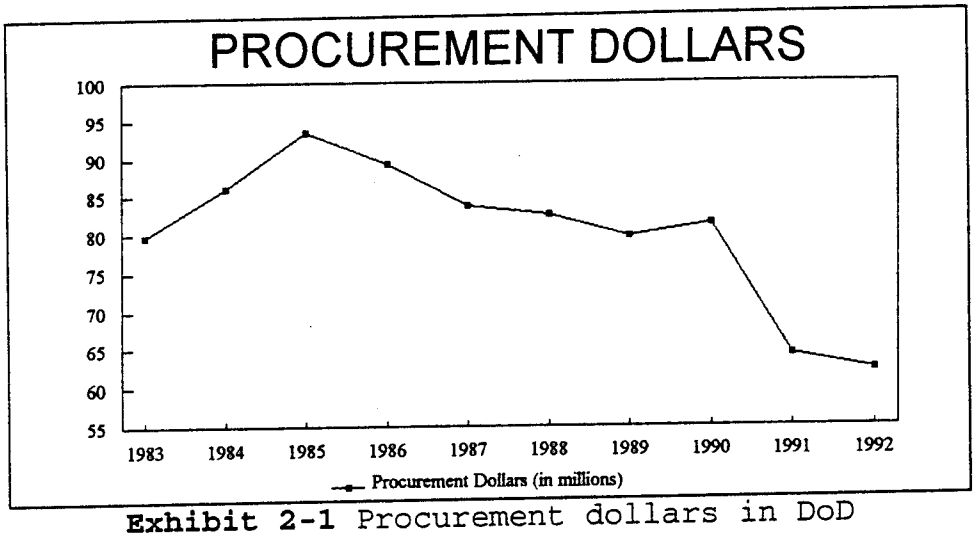

Exhibit 2-1 Procurement dollars in DoD

During the nearly four decades of Cold War, national defense consumed a significant portion of the country's economic resources. Although defense spending as a percentage of Gross Domestic Product (GDP) varied over that period, its share of GDP was never less than 4.8% (in 1978 under President Carter) nor more than 14.5 (in 1953 under President Eisenhower). At the last cyclical peak, the defense budget consumed 6.5% of GDP (in 1986 under President Reagan). Because of major changes in the geopolitical environment and pressing social and economic needs in the United States, the American political system decided to shift resources away from

national defense. By 1997, the DoD budget is expected to fall to 3.6% of GDP, the lowest level of defense spending relative to national income since the end of World War II. The DoD budget consists of two principal types of expenditures: those that pay for personnel, and those that purchase goods and services from the private sector. [Ref. 24, p.iii]

The main beneficiary during the Reagan build-up was the procurement account. This reflected an unchanging historical pattern: when the overall budget has increased, procurement has increased even faster. Unfortunately, the reverse pattern holds for periods during which the total budget declines. Thus, between FY 1985 and FY 1990, while the total budget has declined by one-eighth in real terms, procurement has declined by almost one-third. It is probably safe to assume that procurement will continue to constitute a smaller and smaller portion of the overall defense budget.[Ref. 21, p.7]

3. Defense Industry

The defense industry is adept at adaptation, responsiveness, and even anticipatory innovation. Large backlogs of orders notwithstanding, the paucity of new programs and the decline in overall procurement budgets will require further adaptation and streamlining by the industry. In addition to the workforce reductions that have already begun, it is expected that the industry will experience more of the kinds of structural adaptations that have already taken.[Ref. 21, p.11]

Following the Reagan build-up, as was discovered during the Vietnam drawdown, defense firms had become so specialized that conversion to normal commercial activity was extremely difficult. In addition, with much excess commercial capacity already available, the defense firms had little opportunity to penetrate the strongholds of commercial firms. Under these circumstances, even though the defense resources being released into the economy were small in comparison to those

released after the Korean and Vietnam Wars, the economy was unable to employ them fully or well. They were merely adding to the already existing pool of idle resources and compounding the difficulties in stimulating economic growth.[Ref. 23, p.vi]

A central objective of this study is to document changes that have occurred in the defense industry by observing patterns exhibited by financial ratios. Or to state in an alternative way, to observe if the changes that have occurred in the defense industry have resulted in changes in financial ratio patterns. The next section reviews some of the literature concerning financial ratio patterns.

C. LITERATURE REVIEW

Two branches of literature are relevant to this research. The first branch has examined financial ratios cross-sectionally with the objective of describing the pattern of interrelationships and isolating. Fundamental "dimension" of financial conditions reflected in individual ratios. The second has examined ratios over time with the objective of describing the time series patterns of ratios.

1. Dimensions of Financial Ratios

Hundreds of different financial ratios can be calculated from financial statements. However, previous studies indicate that all financial ratios can be grouped into several categories. This indicates that specific ratios represent higher level concepts (e.g. the current ratio represents liquidity). This allows ratio users to utilize a relatively small number of ratios in order to capture the information about the higher level of concepts.

Several studies have attempted to group financial ratios into a few categories that retain a maximum amount of information about the higher level of concepts. In the following sections, these studies are summarized.

a. Pinches, Mingo, and Caruthers (1973)

The purposes of this study were to: (1) develop empirically based classifications of financial ratios; and (2) measure the long term stability in these classifications over the period 1951-1969. Based on the multivariate procedures employed, it was concluded that the financial ratio factor patterns for industrial firms are: (1) Return on Investment; (2) Capital Intensiveness; (3) Inventory Intensiveness; (4) Financial Leverage; (5) Receivables Intensiveness; (6) Short Term Liquidity; and (7) Cash position. The results indicate that meaningful empirically-based classifications of financial ratios can be determined and that the composition of these groups are reasonably stable over time, even when the magnitude of the financial ratios are undergoing change.[Ref. 20, p.395]

b. Pinches, Eubank, Mingo, and Caruthers (1975)

This study was done: (1) to examine the short term stability of empirically based financial ratio groups over the 1966-69 time period, as opposed to the long term relationships examined previously; (2) to determine the hierarchical relationships among these empirically based financial ratio groups; and (3) to integrate the recent empirical findings on the predictive significance of individual financial ratios with the empirically based similarities identified in this study. Oblique factor analysis of the 48 financial ratios across the 221 industrial firms for 1969 resulted in the identification of seven groupings of financial ratios based upon their empirical similarities. These seven classifications are: (1) Return on Investment; (2) Capital Turnover; (3) Inventory Turnover; (4) Financial Leverage; (5) Receivable Turnover; (6) Short Term Liquidity; and (7) Cash Position. The three higher order groupings-Return on Invested Capital, Overall Liquidity, and Short Term Capital turnover-were found to be unique in that they provide more

comprehensive groupings of financial ratios and assist in specifying the interrelationships that exist among financial ratios and financial ratio groups.[Ref. 19, p.302]

c. Chen and Shimerda (1981)

The following question was studied in this article: "Which ratios, among the hundreds that can be computed easily from the available financial data, should be analyzed to obtain the information for the task at hand?" It was concluded that ratios classified by the same factor are highly correlated, and the selection of one ratio to represent a factor can account for most of the information provided by all the ratios of that factor. The selection of the best representative ratio for a factor is not independent of the ratios selected for other factors. Each ratio contains common as well as unique information. The common information contained in a ratio is represented by factors.[Ref. 4, p.59]

2. Time Series Pattern of Financial Ratios

Time series pattern of the financial ratios gives insight into the adjustment process. There is a common belief that companies try to adjust their financial ratios to "normal" targets. These targets may vary from industry to industry. Different authors discussed the time series properties of the financial ratios in their articles.

a. Lev (1969)

The objective of this study was to test the hypothesis that firms adjust their financial ratios according to industry-wide averages. The results of tests, using a partial adjustment model, indicate that financial ratios are periodically adjusted toward their industry means. One way management can adjust the financial ratios to predetermined targets is to choose from the set of generally accepted accounting measurement rules those which affect the financial ratios in the desired direction (smoothing).[Ref. 13, p.298]

b. Peles and Schneller (1988)

This study concentrated on the time series behavior of financial ratios and the speed of adjustment. The duration of the adjustment process is a function of (a) the benefit and cost to the firm of making the adjustment, and (b) the time needed for a response to the adjustment by market forces operating on the industry and the firm. It is a well established fact that, when some unspecified adjustment process takes place, the serial correlation of changes in any accounting number should be negative (Ball and Watts (1972)). The study relies on this notion that an adjustment process results in a negative coefficient of serial correlation of annual differences. Financial ratios are considered to be important economic factors: sufficiently important to provoke management or markets into a continuous adjustment. Thus, despite the occasional criticism of the informational value of accounting numbers, it appears that market consider this information valuable.[Ref. 18, p.529]

c. Davis and Peles (1990)

This study tested the question of "do equilibrating forces drive a ratio toward a target value, or does the ratio wander around in a Brownian motion." When an equilibrium ratio is found to exist, the strength of the adjustment process can be measured and separated into industry and management components.

To begin the analysis, consider a ratio, V, whose value at time t is denoted V_t. In the absence of any economic shock, the ratio remains at V_t. If, however, at t=1 the ratio's components are subject to a shock, the ratio shifts to a new value, denoted V_{t+1}. In the absence of any further economic shocks, V may either stay at V_{t+1} or revert to V_t. If V stays at V_{t+1}, the shock's effect is permanent and shifts the ratio toward a new level. This behavior known as random walk. If, however, the ratio has a stable equilibrium value and the

shock's effect is temporary, then V reverts to V_t. Reversion may occur in one period or in more than one period. A coefficient of adjustment, β, is the percentage of the remaining deviation adjusted each period. That is, in the period following the shock, β of the shock is reversed; in the next period, another β of the remaining deviation from the equilibrium value is reversed, and so on.

If mean reversion occurs in one period, then the correlation between successive changes in a ratio value is negative; in a random walk, mean reversion does not occur, so, correlation is zero. (Beaver 1970, 67). At its maximum value, -1, there is complete mean reversion; any shock in period one is followed by an equal and opposite equilibrating force in period two. At its minimum value, 0, a shock in one period is not followed by equilibrating force; the ratio follows a random walk. High (low) values of β (i.e., a high [low] negative serial correlation) imply strong (weak) equilibrating forces.[Ref. 6, p.727]

This literature is relevant to the study because: literature related with dimension provide a set of categories for organizing and selecting ratios; literature related with time series provides background about stability and adjustment process. In the next chapter, the research methodology was discussed.

III. METHODOLOGY

A. RATIO SELECTION

1. Introduction

Hundreds of different ratios can be calculated by using the items of information from the basic financial statements. This study focuses on defense industry firms with analysis of the effects of defense budget reduction. For that reason a fairly large number of ratios are selected in order to comprehensively reflect the current patterns in the defense industry.

2. Categorization of Financial Ratios

In the literature, financial ratios are classified into several categories by different authors. In this study four categories of ratios are examined in order to gain insight into the overall condition of the defense industry firms. These ratios are expected to reflect the response of these firms to the reduction of defense budget and economic changes. These four categories are:

1. Profitability
2. Efficiency
3. Liquidity
4. Leverage

The categories, and the ratios used are discussed below.

a. Profitability

Profitability ratios measure the ability of the firm to generate a return on investment or sales. The profitability level is vital for the firm's success and survival. For that reason, these ratios are often used as performance measures.

The profitability ratios will be examined in order to see whether the profitability levels of defense industry firms

have changed during the ten year test period, or not. When calculating profit ratios, the effects of discontinued operations, accounting changes, and extraordinary items are excluded.

b. Efficiency

Efficiency is defined as the ratio of outputs to inputs. The efficiency ratios will be computed in order to measure the firm's capability of generating sales by using its resources. They are mostly expressed as turnover ratios. To the extent that firms can generate a high level of sales by using few resources, they are regarded as efficient firms. It is vital for a firm to operate efficiently. This usually means keeping costs down. [Ref. 8, p.73]

c. Liquidity

Liquidity ratios measure the ability of an entity to maintain both its short and long term debt paying ability. A liquid asset is one that can be converted to cash easily. Liquidity is important for a firm, because even if an entity is on a very profitable course, it could find itself bankrupt if it fails to meet its obligations to creditors.[Ref. 10, p.205]

d. Leverage

Leverage ratios measure the capital structure of the firm. Capital structure ratios provide some insight into tradeoffs made between return and long term risk. These ratios provide information about the business risk and the financial flexibility of the firm. Firms with relatively high debt ratios have higher expected returns when the economy is normal, but they are exposed to risk of loss when the economy is in recession. Thus, firms with low debt ratios are less risky, but they also forgo the opportunity to leverage up their return on equity. Therefore, decisions about the use of debt require firms to balance higher expected returns against increased risk. [Ref. 3, p.56]

3. Financial Ratios

During the selection of financial ratios various criteria were taken into consideration. These were (a) common usage in the practice of financial analysis (b) importance in prior related empirical studies and (c) concern for comprehensiveness. The following ratios listed, by category, have been selected for use in this study.

a. Profitability Ratios

$$\text{Gross Margin} = \frac{\text{Net Sales - COGS}}{\text{Net Sales}}$$

$$\text{Operating Margin} = \frac{\text{N.Sales - Total Cost\&Expenditures}}{\text{Net Sales}}$$

$$\text{Return on Sales} = \frac{\text{Net Income}^{1}}{\text{Net Sales}}$$

$$\text{Return on Assets} = \frac{\text{Net Income}}{\text{Total Assets}}$$

b. Efficiency Ratios

$$\text{Inventory Turnover} = \frac{\text{Net Sales}}{\text{Inventories}}$$

$$\text{Asset Turnover} = \frac{\text{Net Sales}}{\text{Total Assets}}$$

$$\text{Turnover of Working Capital} = \frac{\text{Net Sales}}{\text{Working Capital}^{2}}$$

---

[1]All Net Income figures exclude the effects of discontinued operations, accounting changes, and extraordinary items.

[2]Working capital is the difference between current assets and current liabilities.

$$\text{Fixed Asset Turnover} = \frac{\text{Net Sales}}{\text{Net PPE}^{3}}$$

c. Liquidity Ratios

$$\text{Current Ratio} = \frac{\text{Current Asset}}{\text{Current Liabilities}}$$

$$\text{Quick Ratio} = \frac{\text{Current Asset - Inventories}}{\text{Current Liabilities}}$$

$$\text{Cash Ratio} = \frac{\text{Cash + Marketable securities}}{\text{Current liabilities}}$$

d. Leverage Ratios

$$\text{Equity to Debt} = \frac{\text{S. Equity}}{\text{Total Liabilities}}$$

$$\text{Equity to Asset} = \frac{\text{S. Equity}}{\text{Total Assets}}$$

$$\text{Debt Ratio} = \frac{\text{Total Debt}^{4}}{\text{Total Assets}}$$

$$\text{Retained Earnings to Assets} = \frac{\text{Retained Earnings}}{\text{Total Assets}}$$

B. SAMPLE FIRMS

This study focused on the years from 1983 to 1992. This time span was chosen to assess whether the financial characteristics of the defense industry ratios changed during

---

[3]Property plant and equipment.

[4]Total debt includes both current liabilities and long-term debt.

a period when the environment of the industry clearly did change. Since the defense industry experienced both economic stress and defense budget reductions during that time span, it seemed reasonable to use financial data for that ten year time period.

Data for 38 defense related firms was collected in order to represent the overall industry. In order to identify members of the defense industry, DoD contractors were examined. Companies were selected from among the top 100 defense contractors to U.S. government listed in the "Top 100 Prime Defense Department Contractors for FY 1990." (Source: Directorate for Information Operations and Reports, Department of Defense, Released 1991) The sample of defense related firms examined in this study is listed in Table 1.

Two criteria were considered in choosing a representative sample: size and diversity. The largest DoD contractors were selected, as measured by total assets and net contract value. And firms were selected to represent diverse industry sectors (or subindustries) within the broad area of defense contracting. Annual reports for a period of ten years were requested from the top 100 defense contractors. Sample firms responded with full information to this request.

The defense industry firms can be categorized into eight subindustries. (Source: Military Forum July/August 1988) These subindustries and related firms are:

1. Ships (General Dynamics, General Electric, Litton, Westinghouse, Unisys, Morrison Knudsen, General Motors, Lockheed, Raytheon, United Technologies, Trinity, EG&G)

2. Tank and automotive (General Dynamics, FMC, LTV, General Motors, Harsco, General Electric, Teledyne, Johnson Controls)

3. Aircraft (McDonnell Douglas, United Technologies, Lockheed, General Electric, Grumman, General Dynamics, General Motors, Rockwell, Martin Marietta, Kaman,

Westinghouse, LTV, E-Systems, IBM, Raytheon, CSX, Teledyne, Black and Decker)

4. Missiles (Raytheon, General Motors, General Dynamics, Mcdonnell Douglas, Texas Instruments, Martin Marietta, Lockheed, Rockwell, LTV, General Electric, Gencorp, FMC, Westinghouse, Litton, Honeywell, Ford Motor, GTE, EG&G, Olin)

5. Training systems and services (General Electric, Raytheon, Unisys, General Motors, McDonnell Douglas, General Dynamics, Lockheed, Honeywell, Grumman, Westinghouse, United Industries)

6. Automatic data processing (Unisys, IBM, Honeywell, Eaton, Computer Sciences, General Motors, Martin Marietta, McDonnell Douglas, Gencorp, Harris)

7. Electronics and communications (IBM, GTE, Unisys, Martin Marietta, General Motors, Litton, ITT, Raytheon, General Electric, Westinghouse, Honeywell, Eaton, TRW, Rockwell, Lockheed, Grumman, Harris, Computer Sciences, United Technologies, E-Systems, Teledyne, LTV, McDonnell Douglas)

8. Strategic defense initiative (McDonnell Douglas, Lockheed, Martin Marietta, General Electric, Grumman, Rockwell, TRW, Raytheon, IBM, General Motors, Westinghouse, Honeywell, General Dynamics, Litton, LTV, Unisys, GTE, ITT, Gencorp, Ford Motor, Texas Instruments, Teledyne, FMC, EG&G)

C. DATA SELECTION

The financial information of the defense firms were collected from company annual financial reports , company 10K reports filed with the Securities and Exchange Commission, or Moody's industrial manuals. These three sources provided a sufficient amount of financial data for the study.

In this study 30 specific financial information items were collected to calculate financial ratios. The financial information items were chosen by considering the ratios that would be calculated. These raw data items are listed in Table-2.

TABLE 1

LIST OF DEFENSE FIRMS

BLACK & DECKER
COMPUTER SCIENCE CORP.
CSX
E - SYSTEMS
EASTMAN KODAK
EATON CORP.
EG&G
FMC
FORD MOTOR
GENCORP
GENERAL DYNAMICS
GENERAL ELECTRIC
GENERAL MOTOR
GRUMMAN
GTE
HARRIS
HARSCO
HONEYWELL
IBM
ITT
JOHNSON CONTROLS
KAMAN
LOCKHEED
LTV
MARTIN MARIETTA
MCDONNELL DOUGLAS
MORRISON KNUDSEN
OLIN
RAYTHEON
ROCKWELL INTERNATIONAL
TELEDYNE
TEXAS INSTRUMENT
TRINITY
TRW
UNISYS
UNITED INDUSTRIES
UNITED TECHNOLOGIES
WESTINGHOUSE ELECTRIC

TABLE 2

RAW DATA LIST

	BALANCE SHEET ITEMS
1	Cash and marketable securities
2	Receivables
3	Inventory
4	Total current assets
5	Net plant, property, and equipment (fixed assets)
6	Total assets
7	Accounts payable and accrued expenses
8	Total current liabilities
9	Long term debt
10	Other long term liabilities
11	Total liabilities
12	Preferred stock
13	Retained earnings
14	Total stockholder's equity
	INCOME STATEMENT ITEMS
15	Net sales
16	Cost of goods sold (COGS)
17	Total operating expenses
18	Net operating income
19	Interest expense
20	Income tax expense
21	"Total" income from continuing operations
22	Net Income
23	Earnings per share from continuing operations
24	Earnings per share from discontinuing operations
	CASH FLOW STATEMENT
25	Cash flow from operations
26	Working capital from operations
27	Net capital expenditures
28	Depreciation, amortization, and depletion
	ADDITIONAL DATA ITEMS
29	Total revenue from government
30	Year

The financial information for each firms came from three primary sources:

- Balance sheet (statement of financial condition)
- The income statement (profit and loss statement)
- Cash flows statement (statement of changes in financial position)

D. STRUCTURE OF THE ANALYSIS

In this study, the several ratios representing the four categories of financial condition, were examined in order to gain insight into the behavior of the ratios in the defense industry.

For each ratio, the analysis was designed to answer four broad questions. The next four sections outline the questions addressed, the structure of the analysis and tests designed to answer those questions.

1. *Industry Condition*

The first phase of the analysis will examine the financial condition of the defense industry. This will be examined by focusing on the level (the values) of financial ratios for the industry. The average value of ratios will be measured by both the mean and median of ratio values for the sample firms for each year. Three broad questions will be addressed:

- What has been the industry condition throughout the ten year test period?
- Has the condition changed (and how) from the 1980s to the 1990s.
- If there has been a change, is it significant?

Three approaches will be used to answer those questions. Each relates to the broad issue of the industry condition and

how it has changed, but each provides somewhat different evidence bearing on the question.

PLOTS: The mean and median values for ratios will be plotted to display the general level of ratio values and fluctuations in those values over time.

ANOVA: Oneway (unstacked) analysis of variance will be conducted to address whether mean ratio values differ significantly from year-to-year during the test period. (A later section provides more detail on the ANOVA procedure)

T-tests: A t-test will be conducted to compare the level of ratios at the beginning of the test period with the level at the end. This test is designed to compare values representative of the 1980s with values representative of the 1990s. (A later section also provides more detail on t-tests)

The plots are designed to display the overall trend for a chosen ratio in the industry. General upward or downward trends would suggest steady improvement or deterioration in the financial condition. A U-shaped pattern might be consistent with a change in the industry followed by a return to norm.

A significant ANOVA finding would imply that the overall condition for the industry changes substantially from year-to-year.

A significant t-test finding would imply a specific difference in the condition from the 1980s to the 1990s.

2. *Uniformity Across Firms*

The second phase of the analysis will explore the uniformity in specific aspects of the financial condition across the firms within the industry. This will be achieved by focusing on the dispersion in the level of financial ratios for the firms within the industry. The dispersion will be measured by the variance of the ratio values for the sample firms during each year.

Two broad questions will be addressed:

- How uniform has financial condition been within the industry throughout the test period? How much dispersion exists?

- Has the degree of uniformity changed (and how) from the 1980s to the 1990s?

A visual approach will be used to answer those questions. The variance and standard deviation of the ratio values within the sample will be calculated and plotted to display the dispersion level and fluctuations over time.

The variance is the most commonly used measure of dispersion. It provides quantified information about the variability in the data sample. High variance values would indicate greater dispersion of the observations in the sample. The positive square root of the variance is called the standard deviation. (stats book, p:81)

The plots will be organized to display the overall dispersion trend for a ratio. A general upward or downward trend of variance would suggest decreasing or increasing uniformity. Fluctuation of the variance and standard deviation might point to a period of financial stress in the industry.

3. *Stability Over Time*

The third phase of the analysis will examine the financial stability of the defense industry . This will be examined by focusing on the amount of the year-to-year change in financial condition experienced by firms in the industry. Change for the individual firms will be measured by the absolute value of first annual differences in ratio values. The average amount of change for the industry will be summarized by both the mean and median of absolute first differences during each year of the test period.

Three broad questions will be addressed:

- What has been the financial stability of the industry throughout the ten year period?

- Has the stability changed (and how) from the 1980s to the 1990s?
- If there has been a change, is it significant?

Both visual and statistical approaches will be used to answer these questions. Each relates to the broad issue of the industry stability and how it has changed, but each provides somewhat different evidence bearing on the question.

PLOTS: The mean and median of the absolute value of first annual differences will be plotted to display the general amount of change (instability) and fluctuations in those values over time.

ANOVA: Oneway (unstacked) analysis of variance will be conducted to see whether the mean of absolute differences differs significantly from year-to-year during the test period. (A later section provides more detail on the ANOVA procedure.)

T-tests: A t-test will be conducted to compare the degree of change (instability) at the beginning of the test period with that at the end. This test is designed to compare degrees of change (instability) representative of 1980s with that representative of the 1990s. (A later section will also provides more detail on the t-tests.)

The plots are designed to display the overall trend of the amount of change (instability) in the industry. A general upward trend would indicate increasing financial instability and perhaps distress in the industry.

If economic stress hits the industry, the absolute differences would show an upward trend. If stability did not return to its original "normal" level, the effect of a shock would still appear to exist. A decreasing trend might imply the return to the "normal" stability after weathering a period of stress.

4. *Time Series Pattern*

The fourth phase of the analysis will examine the time series properties of the financial ratios. This will be achieved by examining the relationships between successive year-to-year changes in ratio values. Are changes one year in a ratio related to changes the next? Are increases in a ratio one year followed by increases in the next? Are increases followed by decreases; a return to some "normal" level? Year-to-year changes will be measured by the signed first annual differences of ratio values. The time series characteristics will be summarized by the trend of average (median) values of the change, and analyzed by calculating autocorrelations between first annual differences.

Two broad questions will be addressed:

- What have been the time series properties throughout the ten year test period?
- Has the basic pattern of year-to-year changes in financial ratios changed? In what way?

A visual approach will be used involving plotting the medians of the first annual differences of each financial ratio value throughout the test period. These plots are designed to display the general trend of the annual differences, and fluctuations in those values over time.

Additionally, autocorrelations between the annual differences will be calculated in order to detect systematic patterns. Potential results of the autocorrelation test are as follows:

- If the correlation of the values are near zero, then there is a "*random walk*" pattern.
- If values are negatively correlated, there is a "*mean reverting*" pattern
- If values are positively correlated, then there is a pattern consistent with a trend or momentum in some

direction.

E. STATISTICAL TESTS

The previous section noted that ANOVA, t-tests, and autocorrelations will be used to address some of the research questions. This section provides some more detail on the use of these statistical techniques.

1. *ANOVA test:*

Analysis of variance (ANOVA) is a statistical tool that allows comparison of the means of several populations. The ANOVA test requires three basic assumptions about the measurements in the study:

- The observations must be randomly selected
- The populations from which the observations are taken must all be normally distributed
- The variables in each group must come from populations with equal variances.

In this study oneway (unstacked) ANOVA test is used to compare the means of each year's financial ratio values. The null hypothesis for the test is stated as all the means of annual financial ratio values are equal.

$$H_0 : \mu_{83} = \mu_{84} = \mu_{85} = \mu_{86} = \mu_{87} = \mu_{88} = \mu_{89} = \mu_{90} = \mu_{91} = \mu_{92}$$
$$H_1 : \mu_{83} \neq \mu_{84} \neq \mu_{85} \neq \mu_{86} \neq \mu_{87} \neq \mu_{88} \neq \mu_{89} \neq \mu_{90} \neq \mu_{91} \neq \mu_{92}$$

By comparing the F test result and corresponding p-value acceptance or rejection of the null hypothesis is concluded. P-value is the probability that measure the extent to which the sample data are consistent with conclusion H_0. Decision can be made by comparing the p-value and the α risk. [Ref. 22, p.234]

- If p-value > α risk, then conclude H_0.

- If p-value < α risk, then reject H_0.(or conclude H_1)

Large value of F test result leads to conclusion H_1, as in testing for the presence of a regression relation. The decision rule for F test results is; [Ref. 17, p.662]

- If F test result ≤ F value, conclude H_0.
- If F test result > F value, reject H_0.

2. *T-test:*

T-test is used to answer the question of whether there is a difference between the means of two distinct populations. This test allows one to determine whether one group of data is inherently different from another because of some influences; or whether apparent differences should be attributed to sampling variation.[Ref. 22, p.213]

In this study, t-tests are used to test whether there is a significant difference between the means of first and last three year pooled financial ratio values. For that reason the ratio values of 1983, 1984, and 1985 are pooled in one group and 1990, 1991, and 1992 values are pooled in the other one. The null hypothesis is stated as- there is not any significant difference between the means of two groups.

$$H_0 : \mu_{83\text{-}85} = \mu_{90\text{-}92}$$
$$H_1 : \mu_{83\text{-}85} \neq \mu_{90\text{-}92}$$

By comparing the t-test result (t^*) and the p-value acceptance or rejection of the null hypothesis can be concluded. The p-value comparison is the same as it is in the ANOVA test. The decision can be made with this criterion:[Ref. 17, p.336]

- If $|t^*| \leq$ t-value then conclude H_0.
- If $|t^*|$ > t-value then reject H_0.

3. *Autocorrelation*

The autocorrelation among the variables is a key tool in identifying the basic pattern that describes the data. Correlation is the association (mutual correspondence) between two variables and describes what happens to one variable if there is a change in the other. An autocorrelation is similar to correlation except that it describes the association (mutual correspondence) among values of the same variable but at different periods.[Ref. 14, p.3]

Autocorrelations provide important information about the structure of a data set and of its pattern. In a set of completely random data the autocorrelation among successive values will be close, (or equal to) zero, but data values of strong seasonal and/or cyclical character will be highly autocorrelated. The autocorrelation takes on values between -1 and +1. Negative coefficient between the data sets will indicate successive values are negatively correlated and tend to move in opposite directions.[Ref. 14, p.4] Also negative coefficient of serial correlation of annual differences proves that an adjustment process has taken place.[Ref. 18, p.528]

IV. PROFITABILITY

A. INTRODUCTION

Profitability is the ability of the firm to generate earnings, and is vital for the firm's success and survival. In this study four representative ratios are examined in order to gain insight into the profitability level of the defense industry during the test period (1983-1992).

B. GROSS MARGIN

1. Importance of the Ratio

The gross margin ratio shows the average spread between sales and cost of goods sold (COGS). In a going business, gross margin must be maintained sufficiently high to cover expenses and to provide a satisfactory profit. The gross margin ratio is calculated as follows:

$$\text{Gross Margin} = \frac{\text{Net Sales - COGS}}{\text{Net Sales}}$$

An unacceptably low margin means that on an overall basis too much is being paid for merchandise, or selling prices are too low, or both.[Ref. 8, p.26] Gross margin ratio tends to become lower in a highly competitive environment, and varies widely between industries.

2. Industry Condition

The condition of the defense industry was examined by focusing on the level of gross margin ratios for the industry. The mean and median of the ratio were calculated and are plotted in Exhibit 4-1. The plots show deteriorating ratio levels during the test period. There seems to be a change in the industry condition between the 80s and the 90s. The years of 1984 and 1988 were peak points for this ratio.

In order to be able to answer the question of whether or not the change in the industry condition was significant, ANOVA and t-tests were used. The results are in Table 4-1,

top panel.

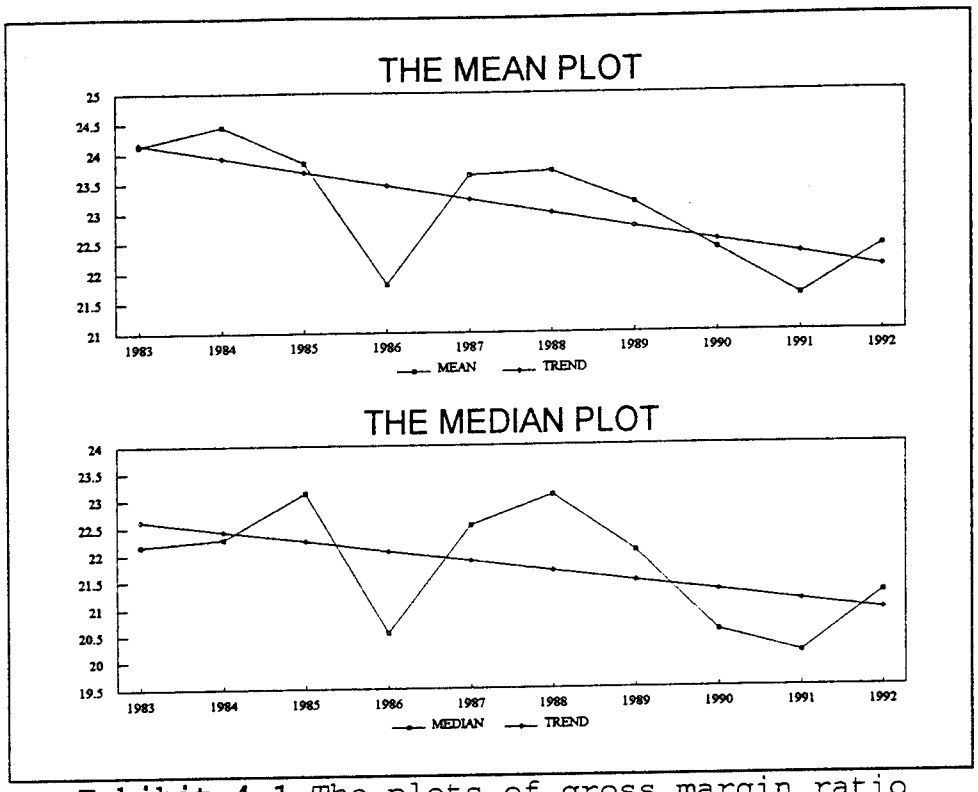

Exhibit 4-1 The plots of gross margin ratio

The oneway ANOVA test was used to compare the means of each year's ratio levels. The F-value is very low and insignificant in this particular test ($p = 0.983$). For that reason, the null hypothesis can not be rejected and there is no significant evidence for differences between the means of successive year's gross margin ratio values. One may conclude that year-to-year changes in the gross margin ratio are not significant.

A t-test was conducted to test whether the change in the industry condition between the early 1980s and early 1990s was significant or not. Since the t-test result of 1.28 is insignificant (p-value of 0.20), the null hypothesis is accepted and it is concluded that there is no significant change in the industry condition during the test period.

However, the null hypothesis of no difference can be rejected at a 80% confidence level. This provides mild evidence that gross margin ratio decreased from the 1980s to the 1990s.

TESTS			GROSS MARGIN
Ratio Level	ANOVA	F*	0.27
		p	0.983
	T Test	t*	1.28
		p	0.20
Abs. First Diff.	ANOVA	F*	0.89
		p	0.527
	T Test	t*	-0.71
		p	0.48

Table 4-1 Statistical test results

Since the industry condition has deteriorated slightly each year, one might not expect a significant change in successive year's levels. However, there is a significant change (at 80% confidence level) between the values of early 1980s and those in early 1990s.

3. Uniformity Across Firms

The variance of the gross margin ratio values across firms within the industry was calculated and is plotted in Exhibit 4-2 in order to display the dispersion level and fluctuations over time. The dispersion in the level of firm ratios shows an increasing trend during the test period. This upward trend in dispersion indicates a decrease in the degree of the industry uniformity. Especially, the degree of the uniformity decreased during the 1990s relative to the 1980s.

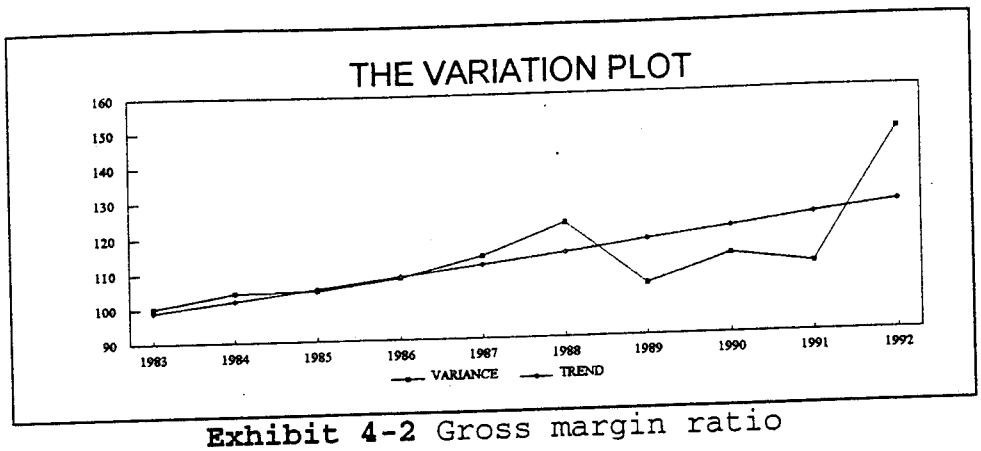

Exhibit 4-2 Gross margin ratio

4. Stability Over Time

The median of the absolute value of the first annual differences was calculated and is plotted in Exhibit 4-3. Visual analysis does not show any significant pattern in the industry stability levels. However, the industry experienced an instability between 1985 and 1988, and returned to a "normal" level at 1988. After 1990 it seems that the level of instability began increasing again.

The oneway ANOVA test was used to see whether the change (instability) is significant between successive year's values. Table 4-1, lower panel, displays the test results. The F-value is quite low and not significant at any reasonable probability level ($p = 0.527$). Thus, the null hypothesis of no difference can not be rejected, and it is concluded that year-to-year rate of change in the gross margin ratio is not significant.

A t-test was conducted to test whether the stability levels changed significantly from the 1980s to 1990s, or not. The findings are listed in the lower panel of Table 4-1. The t-value is quite low when compared to the required value of 1.688. For that reason it is concluded that the stability levels of 80s and 90s did not change significantly.

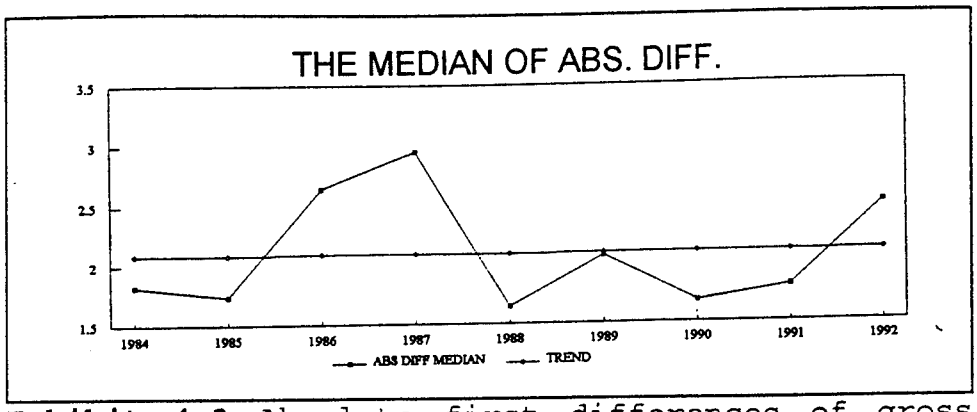

Exhibit 4-3 Absolute first differences of gross margin ratio .

5. Time Series Pattern

The median of signed first annual differences was calculated and is plotted in Exhibit 4-4. The visual analysis does not show any systematic pattern in the industry gross margin ratio. In order to be able to test for year-to-year relationships, autocorrelations were calculated and listed in Table 4-2.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
.056	-.547	-.574	.378	-.269	-.184	-.124	-.277

Table 4-2 Autocorrelations of first differences in the gross margin ratio

Since the autocorrelation values are less than 0.700, they are not so significant. However, there is tendency toward negative serial correlation. Even though the correlations are not highly significant, it can be concluded that there is some evidence consistent with a "mean reverting" pattern during the test period, except 1987. This means that firms which experienced increases (decreases) in gross margin ratios one year tended to follow with a decrease (increase) in the ratio levels the next year.

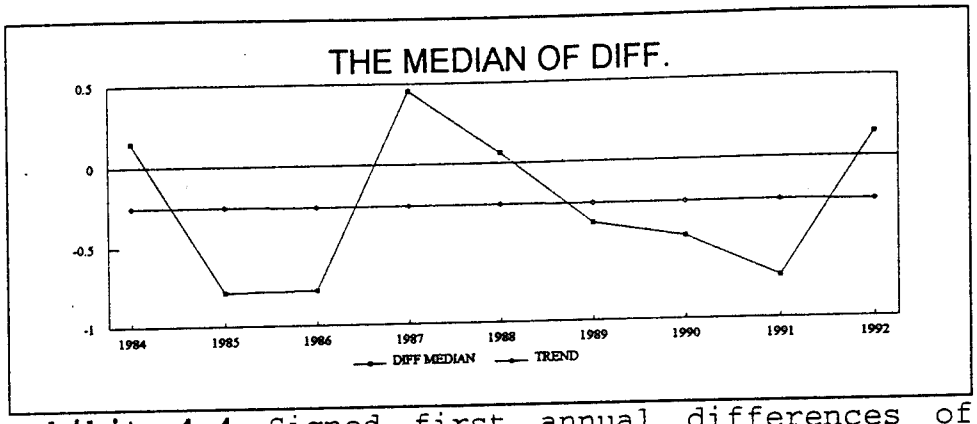

Exhibit 4-4 Signed first annual differences of gross margin ratio

6. Summary

The industry experienced deteriorating gross margins during the test period. Even though visual analysis showed the deterioration in the ratio values, statistical tests provided only mild evidence for a change in the industry condition between the early 80s and early 90s.

The dispersion in the level of gross margin ratios showed an increasing trend. This upward trend implies that the degree of uniformity across firms decreased during the test period.

There was no evidence for any significant pattern in the industry stability levels. However, the industry experienced peak instability between 1985 and 1988, and returned to a "normal" level at 1988.

Even though the autocorrelation values were not highly significant, there was evidence of a "mean reverting" pattern during the test period, except 1987.

C. OPERATING MARGIN RATIO

1. Importance of the Ratio

The operating margin ratio was examined in order to gain insight into the profitability of the defense industry between the years of 1983 to 1992. This ratio is considered to be an

indicator of management skill and operating efficiency. In fact, it has been described as "probably the most important measure one can use to assess a company's competitive position in its industry".[Ref. 8, p.28] The operating margin ratio is calculated as follows:

$$\text{Operating Margin} = \frac{\text{Net Sales - Total Operating Cost and Exp.}}{\text{Net Sales}}$$

This ratio provides a measure of operating income dollars generated by each dollar of sales. While it is desirable for this ratio to be high, changing environmental conditions may cause the operating margin ratio to vary over some time period.

2. Industry Condition

The condition of the industry was explored by focusing on the level of operating margin ratios for the industry. The average ratio values were calculated for the industry from 1983 to 1992, and are plotted in Exhibit 4-5. The visual display shows that the operating margin values deteriorated during the ten year period.

There is an obvious deterioration in the operating margins within the industry, but is this change significant? In order to test the significance of the change, both ANOVA and t-tests were conducted. The results of the tests are listed in the top panel of Table 4-3.

The oneway ANOVA test was used to compare the means of each year's ratio values. Since the F-value is 1.12, quite low and insignificant ($p = 0.344$), the null hypothesis is accepted and one must conclude that there is no significant difference between the means of year-to-year operating margin ratio values.

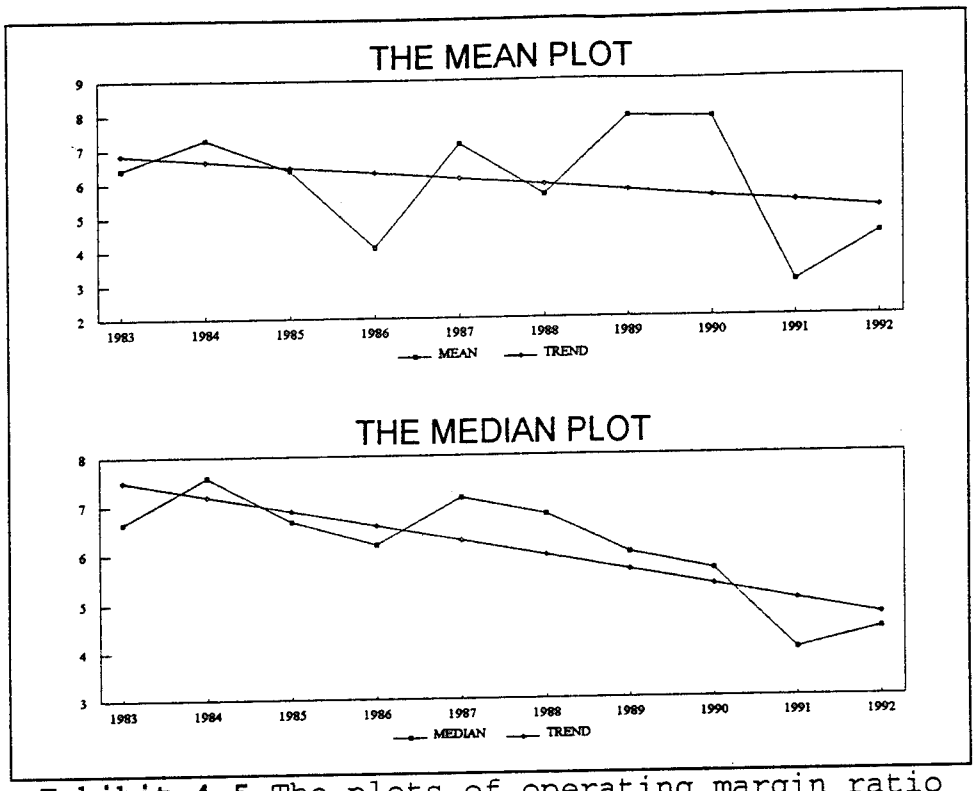

Exhibit 4-5 The plots of operating margin ratio

TESTS			OPERATING MARGIN
Ratio Level	ANOVA	F^*	1.12
		p	0.344
	T Test	t^*	1.27
		p	0.21
Abs. First Diff.	ANOVA	F^*	1.35
		p	0.216
	T Test	t^*	-2.11
		p	0.038

Table 4-3 Statistical test results

A t-test was conducted to test the difference between the average ratio values during the 1980s (1983-1985) and the 1990s (1990-1992). The t-value is 1.27 (p = 0.21). The null hypothesis of no difference can be rejected at 79% confidence level. This provides mild evidence that the operating margin ratio decreased from the 80s to the 90s.

3. Uniformity Across Firms

The variation in the level of operating margin ratios is plotted in Exhibit 4-6. The visual display shows an increasing trend, and indicates a decrease in the uniformity of the operating margins across the firms within the industry. Dispersion of the operating margin ratio within the industry began increasing, especially after 1988. There is a visible decrease in the degree of uniformity from the 1980s to 1990s.

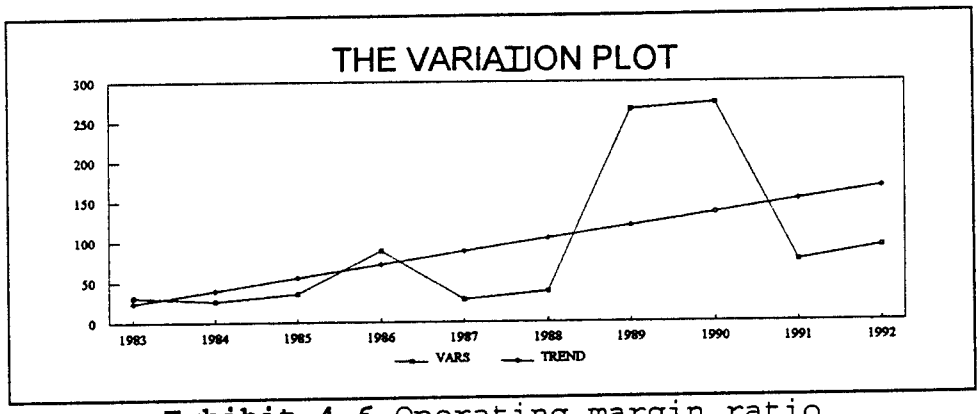

Exhibit 4-6 Operating margin ratio

4. Stability Over Time

The median of the absolute value of first annual differences was calculated and is plotted in Exhibit 4-7. The absolute differences double from 1.242 to 2.489 in ten years. The dramatic effect of the shock can be seen after 1988. The absolute differences showed an increasing trend after 1988, and did not return to their original levels. This indicates that the industry was in an instable condition after 1988.

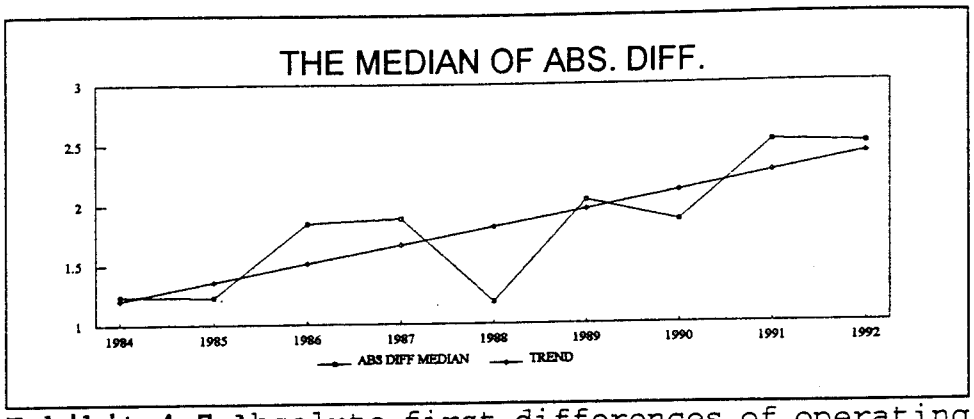

Exhibit 4-7 Absolute first differences of operating margin ratio

The oneway ANOVA test was conducted to see the significance level of the change of year-to-year absolute differences. The findings from the test are listed in Table 4-3, bottom panel. The F-value is 1.35. The null hypothesis of no difference can be rejected only at a 78% confidence level. This provides mild evidence that year-to-year absolute differences increased during the test period. The degree of year-to-year instability increased from 1983 to 1992.

A t-test was used to test whether the degree of stability levels changed significantly from the early 80s to early 90s, or not. The t-test results are listed in the lower panel of Table 4-3. Since the t-value of 2.11 is high and significant ($p = 0.038$), the null hypothesis of no difference is readily rejected at a 95% confidence level. Economic stress hit the industry operating margin in 1988, and since then the industry operating margins have been less stable.

5. Time Series Pattern

The median of the signed first annual differences was calculated and is plotted in Exhibit 4-8 to display the basic patterns of the industry operating margin ratio. The plot does not provide any evidence for a basic trend.

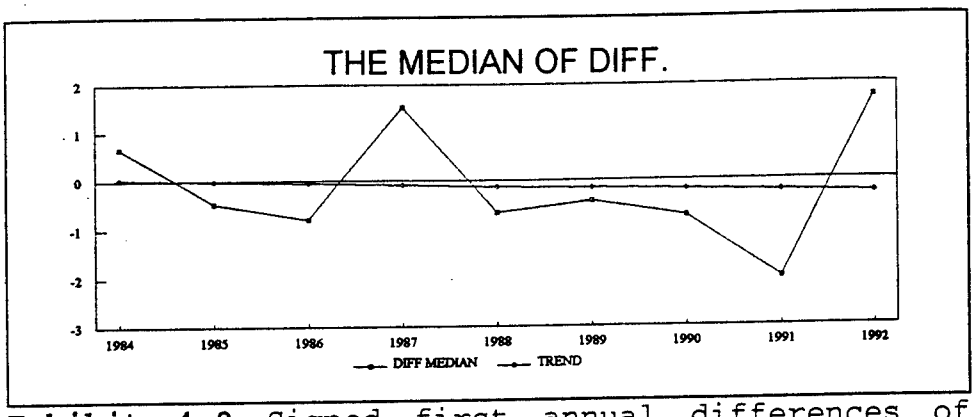

Exhibit 4-8 Signed first annual differences of operating margin ratio

The annual first differences of the operating margin ratio showed a fairly consistent negative coefficient of serial correlation in Table 4-4. Since the autocorrelation values between 1986 and 1988 are greater than 0.700, the industry showed significant negative correlations.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
.078	-.421	-.718	-.660	-.202	-.085	-.126	.000

Table 4-4 Autocorrelations of First Differences of operating margin ratio

This indicates that there was a tendency for firms which experienced increases (decreases) in the ratio one year to follow with a decrease (increase) in the next year. This is consistent with a "mean reverting" pattern.

6. Summary

The condition of operating margin showed a decline during the ten year period, while the dispersion across the firms within the industry soared, particularly in 1989 and 1990. Since the amount of change showed an increasing pattern after

1988, it can be concluded that the chaotic effect of the economic stress forced that particular industry ratio out of a stable condition.

The instability of the industry showed an increasing trend after 1988, and did not return to its original level. This indicates that the industry was in an unstable condition after 1988.

The negative serial correlation indicates that there was a tendency for firms which experienced increases (decreases) in the ratio one year to follow with a decrease (increase) the next year.

It seems that the industry responded to the shock by decreasing their operating margin ratios to survive in the changing environment. This decrease can be caused by either increasing cost and expenses, decreasing sales revenues, or a combination of both. It is obvious that the industry is experiencing lower levels of profitability relative to the early 1980s.

D. RETURN ON SALES

1. Importance of the Ratio

The return on sales ratio measures, relative to sales, the difference between what a company takes in and what it spends in conducting its business. The return on sales ratio is calculated as follows:

$$\text{Return on Sales} = \frac{\text{Net Income}}{\text{Net Sales}}$$

A high value usually goes hand-in-hand with long-term business success. High returns provide capital for growth as well as protection against unexpected economic downturns. The most likely cause for an unsatisfactorily low return is insufficient gross margin. Another possibility is that expenses are too high relative to sales. Conversely, high

returns are common for firms offering proprietary products, or possessing some form of competitive edge.[Ref. 8, p.35]

2. Industry Condition

The condition of the industry was examined by focusing on the level of industry return on sales ratio. This particular ratio was calculated for the industry from 1983 to 1992, and is plotted in Exhibit 4-9. The visual analysis indicates that there was a declining trend during the test period. The industry experienced decreasing ratio values during the late 1980s and early 1990s.

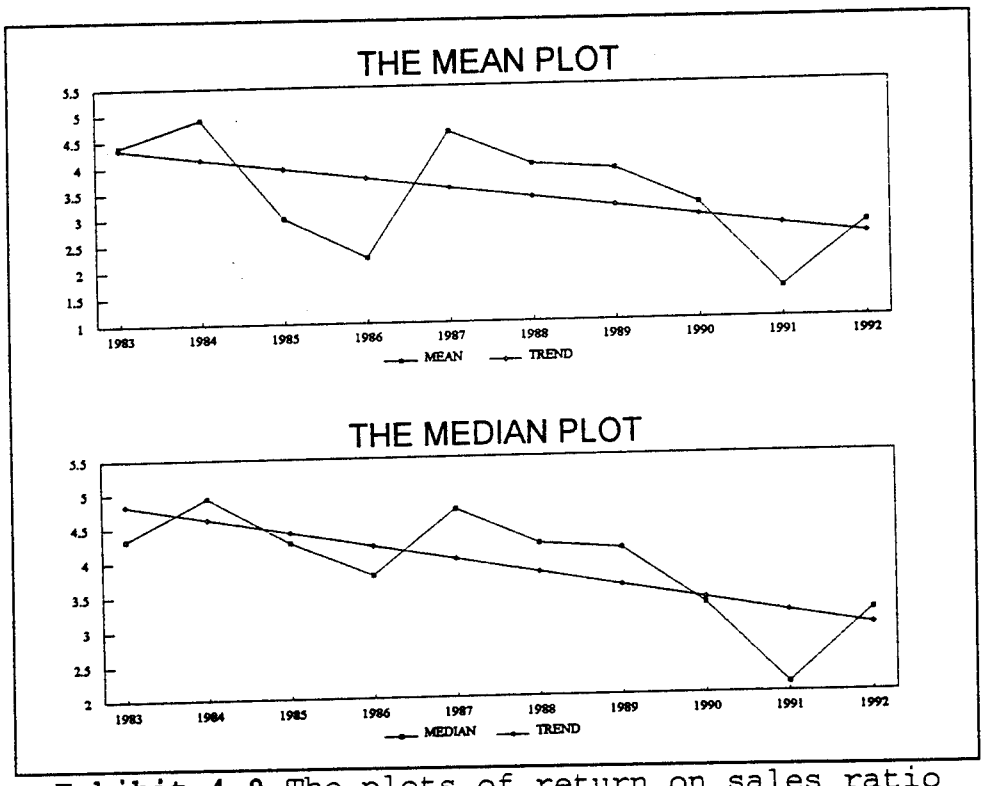

Exhibit 4-9 The plots of return on sales ratio

In order to test the significance of the change, ANOVA and t-test were used. The results are in Table 4-5, upper panel.

The oneway ANOVA test was used to compare the means of each year's return on sales ratio values. The F-value is quite high when compared to some of the other tests. The null hypothesis of no difference is easily rejected at a 95% confidence level. This provides strong support for the finding that there is a significant change between year-to-year industry condition.

TESTS			RETURN ON SALES
Ratio Level	ANOVA	F^*	2.50
		p	0.009
	T Test	t^*	3.22
		p	0.0015
Abs. First Diff.	ANOVA	F^*	1.15
		p	0.330
	T Test	t^*	-1.56
		p	0.12

Table 4-5 Statistical test results

A t-test was conducted to test the significance of differences in the average level of ratio values between the 1980s and 1990s. The t-value is 3.22, quite high. The null hypothesis of no difference is readily rejected. This provides strong support for the finding that there was significant evidence of a difference between 1980s industry return on sales ratio values.

3. Uniformity Across Firms

The variance of the ratio levels across firms was computed and is plotted in Exhibit 4-10 to display the overall

uniformity within the industry. There is no indication of an upward or downward trend. However, there is an outlier at 1986, which indicates that there was a wide range of ratio values among the industry firms during that year.

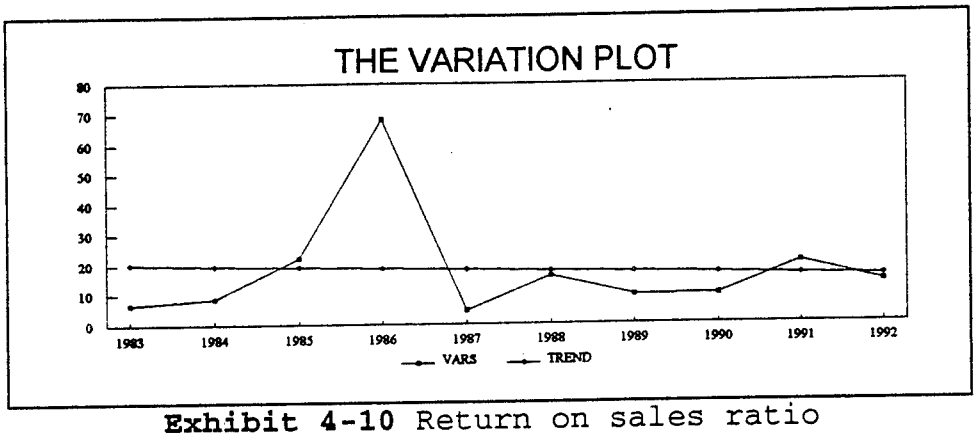

Exhibit 4-10 Return on sales ratio

4. Stability Over Time

The median of the absolute value of the first differences was calculated and is plotted in Exhibit 4-11. The median of the absolute differences showed a slight upward trend during the test period. However, the peak periods of instability occurred in 1986-1987.

The oneway ANOVA test was conducted to test the significance of the change of year-to-year absolute differences. Findings from the test are in Table 4-5, bottom panel. The F-value of 1.15 is quite low, and not significant at any reasonable probability level ($p = 0.330$). Thus, the null hypothesis of no difference can not be rejected, and it is concluded that year-to-year changes (instability) in the return on sales ratio are not significant.

A t-test was conducted to test for any significant change in stability between the early 80s and early 90s. The test results are listed in the bottom panel of Table 4-5. The t-value is 1.56 ($p = 0.12$). The null hypothesis of no difference can be rejected at a 88% confidence level. This

provides mild evidence that the rate of change in the return on sales ratio decreased from the 1980s to 1990s. Overall, return on sales was more stable in the 90s than the 80s.

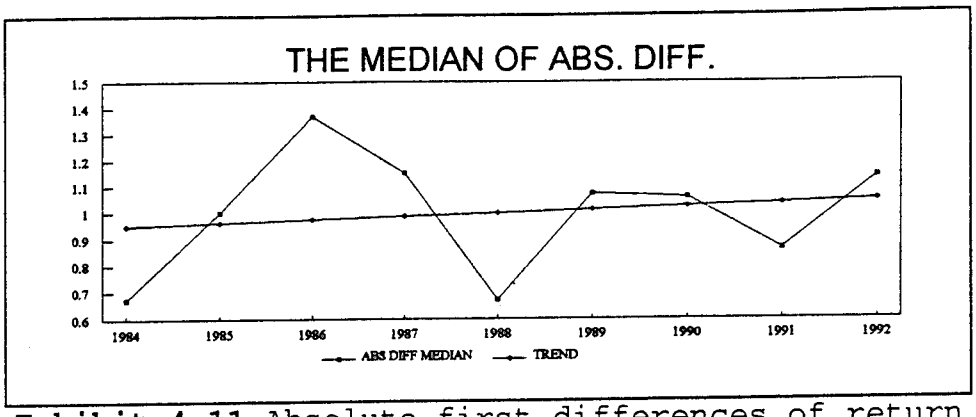

Exhibit 4-11 Absolute first differences of return on sales ratio

5. Time Series Pattern

The median of the signed first annual differences is plotted in Exhibit 4-12 to display time series patterns. The plots of the first annual differences show an alternating pattern (positive changes followed by negative changes) throughout the ten year test period.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
-.426	-.410	-.841	-.818	-.767	-.355	-.368	-.363

Table 4-6 Autocorrelations of the first differences of return on sales ratio

The successive year's values of the industry return on sales ratio showed a negative coefficient of serial correlation in Table 4-6. Between 1986 and 1988 especially, the ratio experienced significant autocorrelations. Increases in the ratio values tended to be followed by decreases, and vice versa. The relationship of the successive year-to-year

changes indicates that there was a "mean reverting" pattern in the industry.

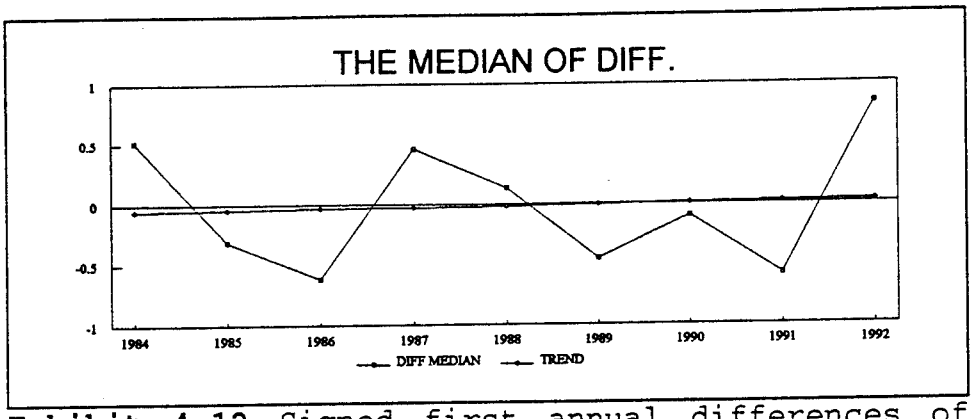

Exhibit 4-12 Signed first annual differences of return on sales ratio

6. Summary

The defense industry experienced significant decrease in the return on sales during the ten year test period. The economic stress caused a change in the industry condition.

There was no upward or downward trend in the degree of uniformity across the firms within the industry, except slight deterioration. However, in 1986 the industry experienced wide dispersion among the firms.

The return on sales ratio was more stable during the early 90s when compared to the early 80s, indicating less year-to-year fluctuation in profitability for the industry.

There was a negative coefficient of serial correlation among the successive year's values of the industry return on sales ratio. Increases in this ratio values for individual firms tended to be followed by decreases, and vice versa. The relationship of the successive year-to-year changes indicates that there was a "mean reverting" pattern in the industry.

As a main customer to this industry, U.S. government might benefit from low returns, by paying less for the goods and services of the firms. Obviously, decreasing returns

might increase cost sensitivity in the defense industry.

E. RETURN ON ASSETS

1. Importance of the Ratio

The return on asset ratio measures the earning power of the firm's investment in assets, and indicates how successful a management is in putting its assets to work in making profits. The return on assets ratio is calculated as follows:

$$\text{Return on Assets} = \frac{\text{Net Income}}{\text{Total Assets}}$$

It should be noted that in this ratio it does not matter whether the assets represent creditor equity or owner's equity.[Ref. 8, p.38] This ratio is important for the defense industry, since the industry is capital intensive and highly competitive.

2. Industry Condition

The industry condition was examined by focusing on the level of industry return on asset ratio. The mean and median of the levels are plotted in Exhibit 4-13 to display the general level of ratio values, and their fluctuations over time.

The plots indicated that there was a considerable amount of deterioration in the industry condition, since return on asset ratio values declined almost 50%. There is a general downward trend in this particular ratio. In order to test the significance level of the change, both ANOVA and t-tests were used. The results from the tests are listed in Table 4-7,top panel.

A t-test was used to see whether the industry condition changed significantly from the early 1980s to early 1990s. The t-value is quite high. This provides strong evidence of a major change in the industry condition occurred between 1980s and 1990s.

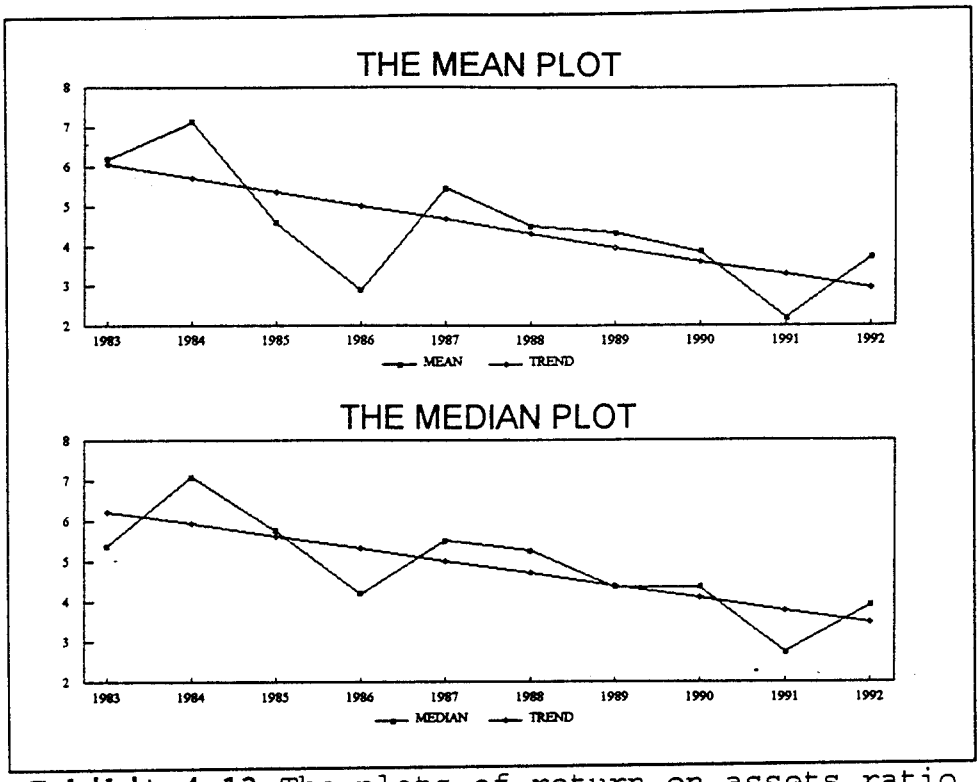

Exhibit 4-13 The plots of return on assets ratio

TESTS			RETURN ON ASSETS
Ratio Level	ANOVA	F^*	2.93
		p	0.002
	T Test	t^*	4.47
		p	0.000
Abs. First Diff.	ANOVA	F^*	1.17
		p	0.317
	T Test	t^*	-0.60
		p	0.55

Table 4-7 Statistical test results

The oneway ANOVA test was designed to see whether or not ratio values differ significantly year-to-year. The null hypothesis is readily rejected, since the F-value is quite high when compared to required value at a 95% confidence level. This provides strong evidence that there was a significant change in the industry condition in successive years during the test period.

3. Uniformity Across Firms

Uniformity across firms within the industry was examined by focusing on the dispersion in the return on asset ratio values. The variation plot in Exhibit 4-14 does not show any general pattern, except a slight downward trend. However, there was wide dispersion, or low uniformity, in the industry primarily during 1986. It seems that there was no significant change in the degree of industry uniformity from early 80s and early 90s.

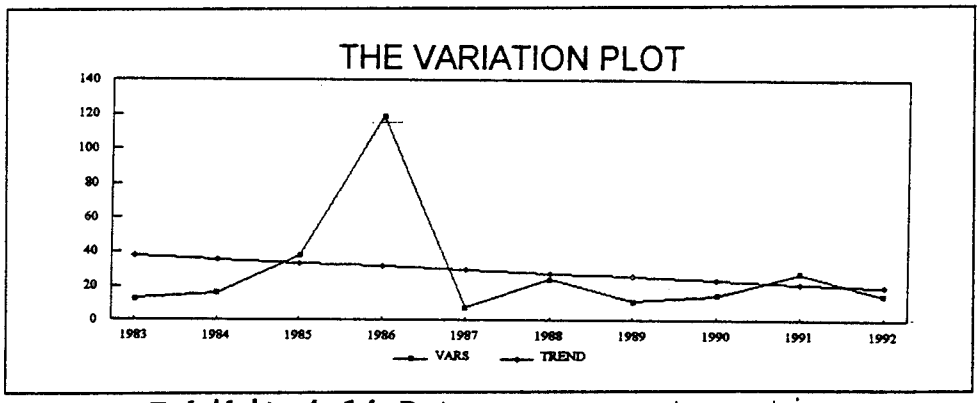

Exhibit 4-14 Return on assets ratio

4. Stability Over Time

Financial stability of the defense industry was explored by focusing on the absolute value of the first annual differences in return on assets. The median of the absolute differences is plotted in Exhibit 4-15. The plot shows a

slight declining trend during the test period. The years 1985 and 1986 appear to be periods of relatively less stability.

The statistical tests were used to test the significance of the change (instability) in the industry during the test period, and results are listed in Table 4-7, bottom panel.

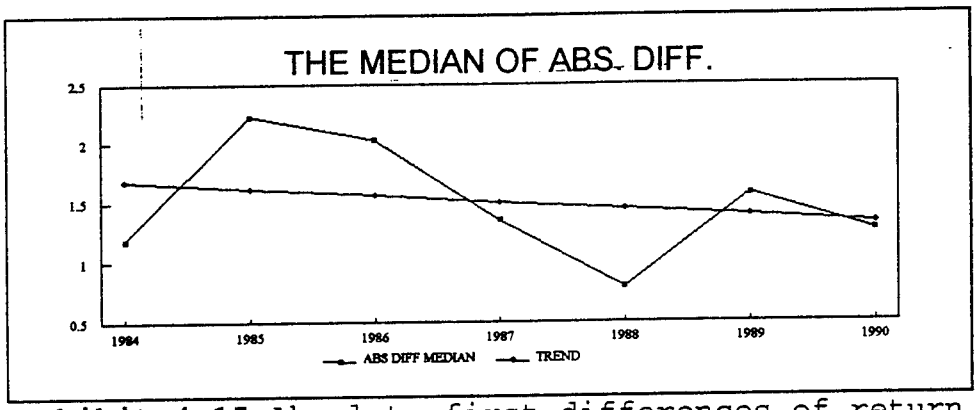

Exhibit 4-15 Absolute first differences of return on assets ratio

The oneway ANOVA test was used to test the significance of the rate of year-to-year change (instability) in the industry during the test period. The F-value is quite low and insignificant at any reasonable probability level. Thus, the null hypothesis of no difference is accepted, and one can conclude that there was no significant evidence for a change (instability) in the industry during the successive years of the test period.

A t-test was conducted to see the significance of the change (instability) in the industry between early 1980s and early 1990s. There is no significant evidence for a change (instability) in the industry between the early 80s and early 90s, since the t-value is too low to reject the null hypothesis.

5. Time Series Pattern

The time series pattern of the industry return on assets ratio was examined by focusing on the signed first annual differences. The median of those values is plotted in Exhibit 4-16. The plot indicates that the increases (decreases) in one year ratio values followed with a decrease (increase) in the next year (pendulum movement).

In order to examine this pattern, autocorrelations of the successive year's values were calculated and are listed in Table 4-8. The negative serial correlations, significant particularly between 1986 and 1989, indicate a "mean reverting pattern" for the industry.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
-.343	-.242	-.858	-.810	-.801	-.277	-.380	-.510

Table 4-8 Autocorrelations of the first differences of return on assets ratio

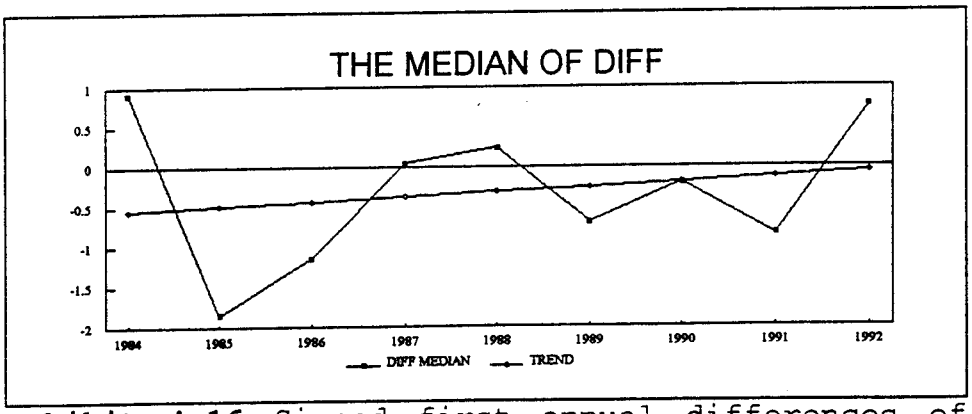

Exhibit 4-16 Signed first annual differences of return on assets ratio

6. Summary

There were many changes occurring in the industry return on asset ratio throughout the ten year test period. The industry experienced considerable amount of deterioration in this particular ratio during that period. There was a highly significant change in the industry condition between the early 80s and 90s.

The uniformity across firms within the industry did not show any significant change during the test period. The dispersion levels were almost constant except in 1986.

The instability over time showed a decreasing trend throughout the test period. The years of 1985 and 1986 appear to be periods of relatively less stability. However, the tests conducted do not indicate that the change in stability was significant.

The negative serial correlations indicate a "mean reverting pattern" for the industry throughout the test period.

The defense industry is capital intensive and requires expensive and sophisticated machinery. It seems that the industry was not getting as high returns from their assets as they had in the early 1980s.

F. SUMMARY OF FINDINGS FOR PROFITABILITY RATIOS

Profitability is a vital factor for the success and the survival of the defense industry. Four different ratios were examined in order to gain insight into the profitability pattern of the defense industry throughout the ten year period.

There was an obvious deterioration in the industry profitability levels during the test period. There were slight decrease in the gross margin and operating margin ratios. However, return on sales and return on assets ratios showed a significant change during the test period. This

reality indicates that, even though the industry was generally able to keep their profit margins in a reasonable levels, they could not keep returns both on their assets and sales, as high as they had been.

This decrease in the profitability ratios can be explained by either increasing cost and expenses, decreasing sales revenues, or a combination of both. But it is obvious that, the defense industry overall has experienced declining profitability. This industry used to be known as a "cash cow", but conditions have changed.

There were some years of relatively greater dispersion across the industry, but those years were different for each ratios. For that reason the ratios do not indicate that any clear change in the uniformity of the profitability levels within the industry has occurred.

Generally the largest year-to-year changes in profitability occurred during the 1980s (for gross margin, return on sales, and return on assets) and those ratios are more stable now. Operating margin is an exception, showing gradually decreasing stability over time.

There is a consistent evidence of "mean reverting" pattern in all examined profitability ratios. This means that there was a tendency for firms which experienced the largest increases (decreases) in profitability one year to follow with a decrease (increase) in profitability the next year.

V. EFFICIENCY

A. INTRODUCTION

Efficiency ratios of the defense industry were examined in order to measure the firms' capability of generating sales by using their resources. To the extent that firms can generate a high level of sales by using few resources, they are regarded as efficient firms. As long as the ratio values increase (decrease), one can conclude that the efficiency of the industry is improving (deteriorating). Efficiency is a key success factor for the industry.

B. INVENTORY TURNOVER

1. Importance of the Ratio

Inventory turnover is a popular indicator of operating efficiency, appraising how well management controls capital committed to inventory. The inventory turnover ratio is calculated as follows.

$$\text{Inventory turnover} = \frac{\text{Net sales}}{\text{Inventories}}$$

An increasing inventory may be healthy if associated with growing sales, or an accumulation of goods resulting from reduced sales and inefficient purchasing. This turnover ratio helps to reveal which is the case.[Ref. 8, p.94]

2. Industry Condition

The condition of the defense industry was examined by focusing on the level of industry inventory turnover ratio values. The mean and median of this ratio were calculated and are plotted in Exhibit 5-1. The plots indicate an increasing trend throughout the test period, especially after 1985.

There is a visible change in the ratio levels. In order to test whether this change was significant or not, both Anova and t-tests were conducted. The results of these statistical tests are listed in the top panel of Table 5-1.

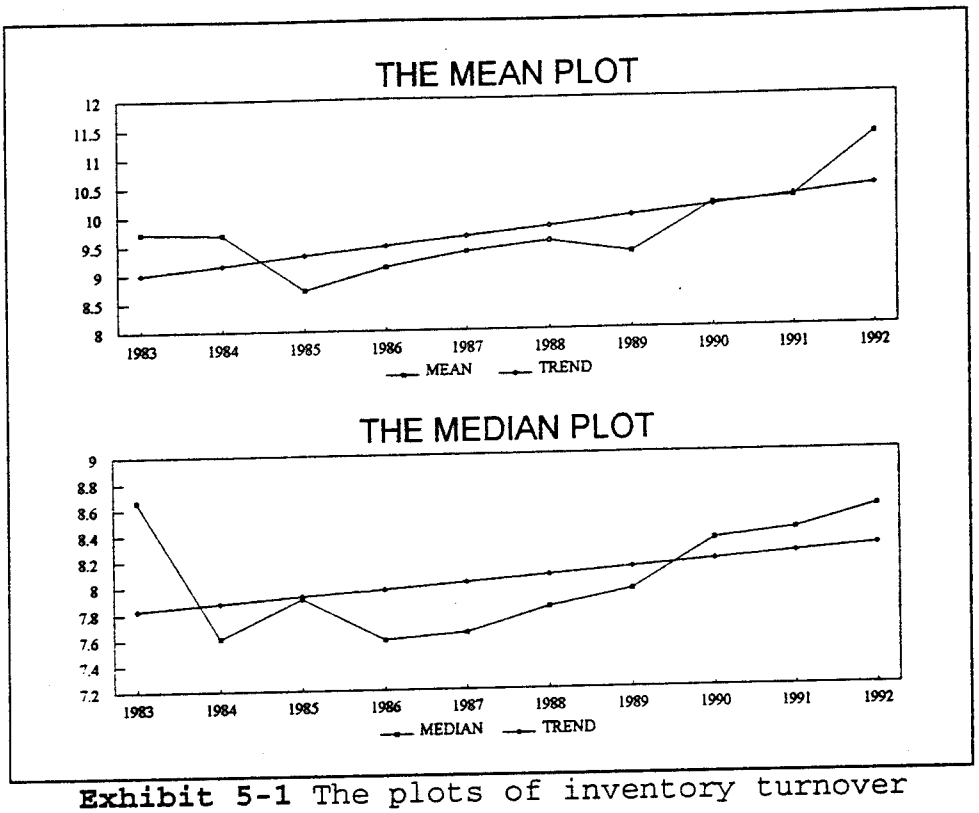

Exhibit 5-1 The plots of inventory turnover

The oneway ANOVA test was used to compare the means of successive year's ratio levels. The F-value is 0.48, quite low and insignificant at any reasonable probability level (p= 0.890). Thus, the null hypothesis of no difference is accepted, and it is concluded that year-to-year changes in the inventory turnover ratio are not significant.

A t-test was conducted to test whether the change in the industry condition between the early 80s and early 90s was significant or not. The t-test value is 1.30 (p= 0.19). The hypothesis of no change can be rejected at an 81% confidence level. This provides mild evidence that the inventory turnover ratio increased from the 1980s to 1990s.

The industry experienced increasing inventory turnover ratios throughout the ten year period. Even though year-to-

year changes are not highly significant, the industry condition changed significantly from the early 1980s to early 1990s.

3. Uniformity Across Firms

The variance of the inventory turnover ratio was calculated and is plotted in Exhibit 5-2 in order to display the overall dispersion level. The plot shows an increasing trend in dispersion, especially after 1985. The visual analysis indicate that the degree of uniformity across the firms within the industry decreased more apparently in the early 1990s.

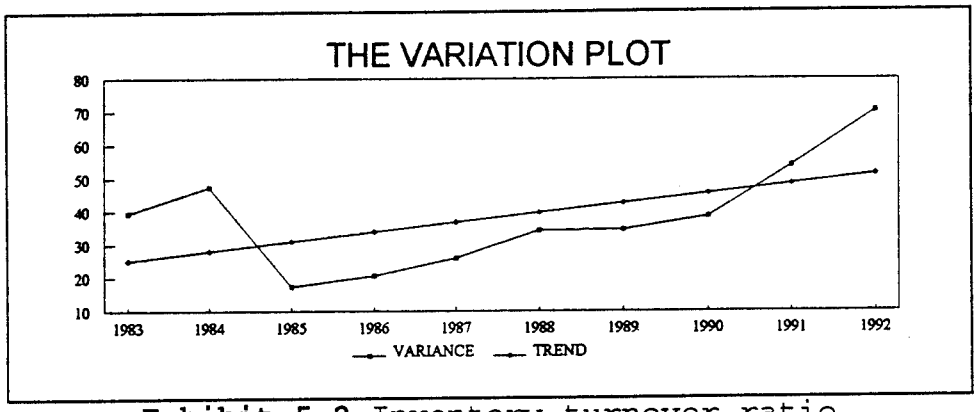

Exhibit 5-2 Inventory turnover ratio

4. Stability Over Time

The median of the absolute value of first annual differences was calculated and is plotted in Exhibit 5-3. Visual analysis shows that the stability in the industry tended to decrease after 1989. The industry experienced stability between 1987 and 1989. The following statistical tests were used to test the significance of the change in the industry stability level.

The oneway ANOVA test was conducted to test the significance of a change (instability) between successive years. The test result is in the lower panel of Table 5-1. The F-value is quite low and not significant at any reasonable

probability level. Thus, the null hypothesis of no difference is accepted, and it is concluded that the year-to-year differences in the rate of change in the inventory turnover ratio is not significant.

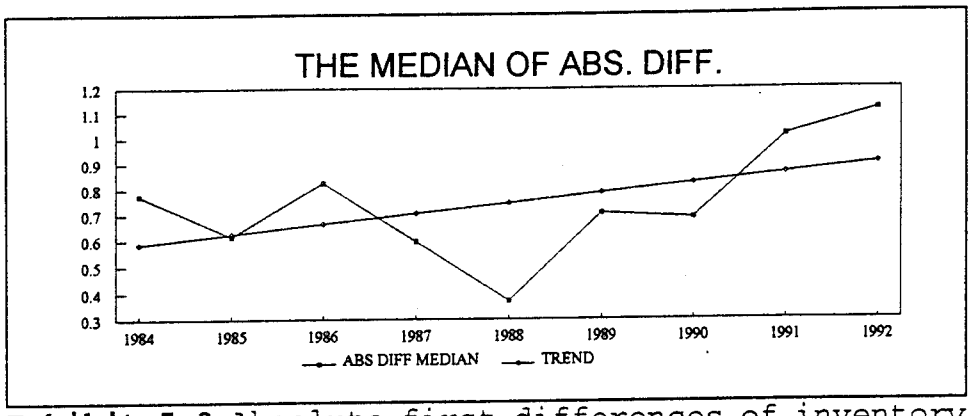

Exhibit 5-3 Absolute first differences of inventory turnover ratio

TESTS			INVENTORY TURNOVER
Ratio Level	ANOVA	F*	0.48
		p	0.890
	T Test	t*	-1.30
		p	0.19
Abs. First Diff.	ANOVA	F*	1.07
		p	0.384
	T Test	t*	-0.60
		p	0.55

Table 5-1 Statistical test results

A t-test was used to see whether the stability levels changed significantly from the 1980s to 1990s, or not. The test results are in Table 5-1, lower panel. The t-value is quite low and insignificant at any reasonable probability level. Consequently, the null hypothesis of no difference is accepted, and it is concluded that there is no significant change in the degree of stability between 80s and 90s.

5. Time Series Pattern

The median of signed first annual differences was calculated and is plotted in Exhibit 5-4. The plot shows an increasing overall trend for annual differences. In order to examine the year-to-year relationships, autocorrelations were calculated and are displayed in Table 5-2.

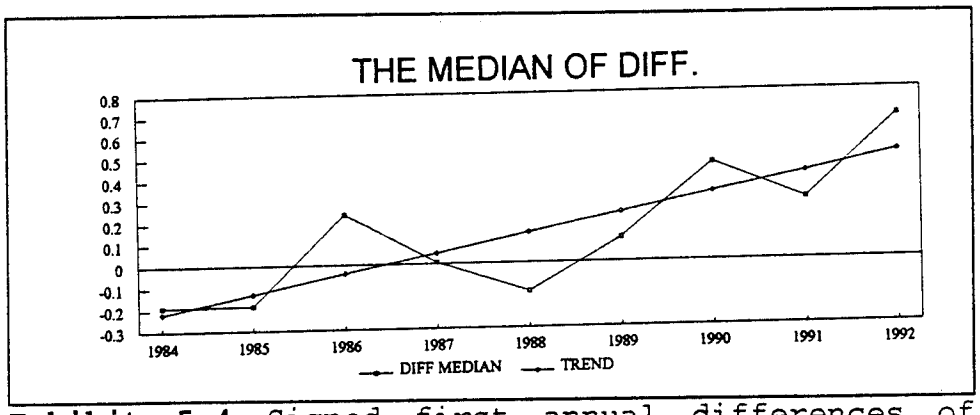

Exhibit 5-4 Signed first annual differences of inventory turnover ratio

Since the autocorrelation values are less than 0.700, none of them are significant. However, between 1986 and 1990 there is tendency toward positive serial correlation. This indicates that there was a pattern consistent with a trend or momentum in some direction. During that period, the increases (decreases) in inventory turnover ratio one year tended to be followed by an increase (decrease) in the next. This is consistent with the trend toward greater dispersion across the

industry that was noted earlier.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
-.252	-.450	.115	.269	.174	.044	-.157	.150

Table 5-2 Autocorrelations of first differences of inventory turnover ratio

6. Summary

The industry experienced slightly increasing inventory turnovers during the ten year test period. Even though the plots showed increasing trend, statistical testing did not provide any evidence for a significant change in the industry condition.

The degree of uniformity across the firms within the industry showed a decreasing trend throughout the test period. This decrease in uniformity was more apparent in the early 1990s.

There was no evidence for any significant pattern in the industry stability levels. However the industry stability level tended to decrease slightly in the early 90s.

Between 1986 and 1990 there was a tendency toward positive serial correlation in the industry inventory turnover ratio. This indicates that there was a pattern consistent with a trend or momentum in some direction.

C. ASSET TURNOVER

1. Importance of the Ratio

The asset turnover ratio measures the rate at which sales were created using the company's asset base. It is an indicator of efficiency and managerial performance. The asset turnover ratio is calculated as follows:

$$\text{Asset turnover} = \frac{\text{Net sales}}{\text{Total assets}}$$

Low ratios indicate insufficient sales or the need to reduce unproductive assets. High ratios point to an ability to create and process sales at low cost. A long term upward trend in the ratio demonstrates management's success in developing its markets and in reaping the rewards of division of labor. A downward trend signals deteriorating efficiency, accumulation of assets not contributing to current production or an increase in revenues.[Ref. 8, p.90]

2. Industry Condition

The condition of the industry was explored by analyzing the average level of the asset turnover ratio. The average ratio values were calculated and are plotted in Exhibit 5-5. The plots demonstrate an apparent downward trend during the test period.

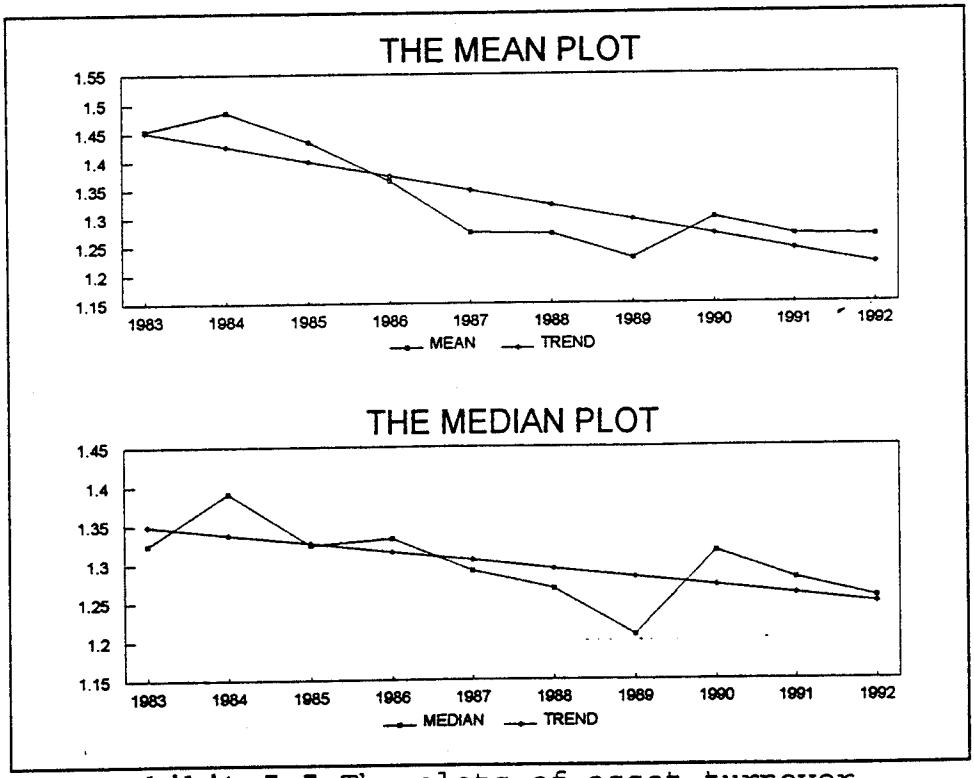

Exhibit 5-5 The plots of asset turnover

In order to test the significance of this deterioration, both ANOVA and t-tests were conducted. The findings from those tests are listed in the top panel of Table 5-3.

The oneway ANOVA test was used to compare the means of each year's asset turnover ratio values. The F-value is quite low and insignificant at any reasonable probability level (p=0.38). Thus, the null hypothesis of no difference can not be rejected, and one must conclude that year-to-year changes in the asset turnover ratio are not significant.

A t-test was conducted to test the significance of differences between the average ratio values of the early 80s and early 90s. The t-value is quite high when compared to some of the other tests. The null hypothesis of no difference is readily rejected at a 95% confidence level. This provides strong support for the finding that there is a highly significant decrease in the industry asset turnover ratio between 1980s and 1990s.

TESTS			**ASSET TURNOVER**
Ratio Level	ANOVA	F*	1.07
		p	0.380
	T Test	t*	2.37
		p	0.019
Abs. First Diff.	ANOVA	F*	1.97
		p	0.050
	T Test	t*	2.11
		p	0.036

Table 5-3 Statistical test results

3. Uniformity Across Firms

The dispersion in the industry asset turnover ratio measures the uniformity across the firms within the industry. The variation in the level of this particular ratio is plotted in Exhibit 5-6. The visual display demonstrates an increasing trend in dispersion across firms within the industry. This indicates that uniformity across the firms within the industry decreased throughout the test period. After 1986, the decrease in the uniformity is even more apparent. There is a visible change in the degree of uniformity from the 1980s to 1990s.

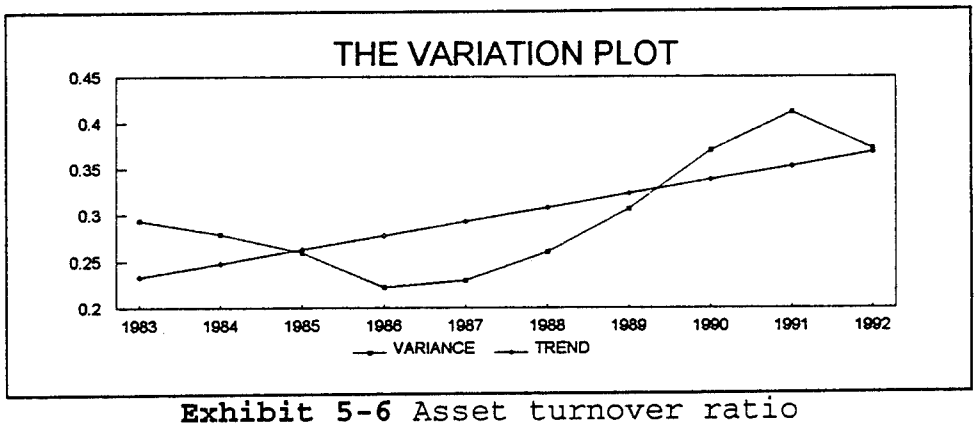

Exhibit 5-6 Asset turnover ratio

4. Stability Over Time

The absolute yearly first differences were examined in order to gain insight into the stability of the defense industry between 1983 and 1992. For that reason the median of the absolute differences is plotted in Exhibit 5-7. The plot shows a decrease in the rate of change (instability) throughout the test period. The industry experienced a high level of instability during 1985. However, after 1986 they experienced more stable asset turnover ratios. Statistical tests were used to test the significance of a change (instability) in the industry, and the test results are displayed in Table 5-3, lower panel.

The oneway ANOVA test was conducted to see the significance level of the change in successive years' absolute differences. Since the F-value is quite high and significant when compared to some of the other tests; the null hypothesis of no difference is easily rejected at a 95% confidence level. This provides strong evidence for the finding that year-to-year stability levels changed significantly during the test period.

A t-test was used to test whether or not the degree of the stability levels changed significantly from the early 1980s to early 1990s. The t-value is 2.11, quite high (p= 0.036). The null hypothesis of no difference is rejected at 95% confidence level. This provides strong support for the conclusion of significant change in the stability levels from the 1980s to 1990s. Although these findings are statistically significant, it would appear that they are driven by the unusual results for 1985.

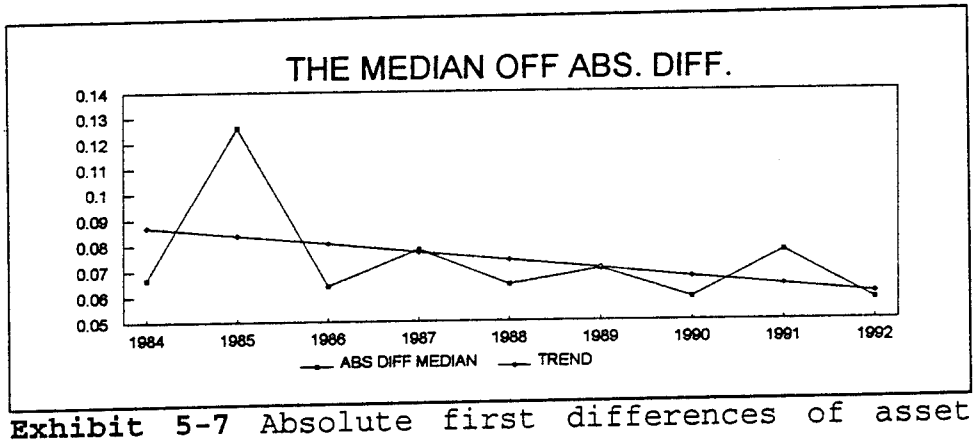

Exhibit 5-7 Absolute first differences of asset turnover ratio

5. Time Series Pattern

The signed first annual differences of asset turnover ratio were examined in order to detect the time series pattern for the industry. The median of signed annual differences is plotted in Exhibit 5-8 to display the pattern. The plot shows a slight upward overall trend throughout the test period.

The autocorrelations of signed annual differences were computed and are displayed in Table 5-4. Since the autocorrelation values are near to zero, there is a "random walk" pattern in the asset turnover ratio.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
-.081	-.383	-.316	.176	.009	-.360	-.084	-.308

Table 5-4 Autocorrelations of first differences of asset turnover ratio

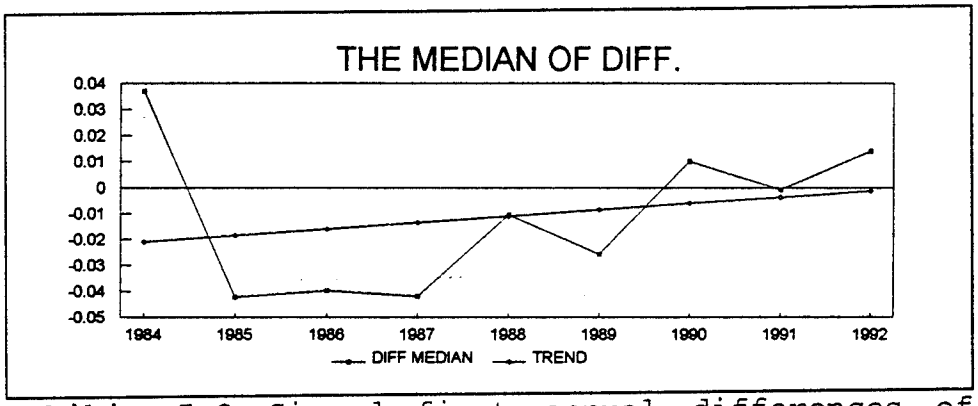

Exhibit 5-8 Signed first annual differences of asset turnover ratio

6. Summary

Asset turnover ratio within the industry showed a decreasing trend throughout the test period with a highly significant change in the ratio values between 1980s and 1990s. It can be concluded that the industry condition deteriorated from 1980s to 1990s. The downward trend of industry asset turnover ratio indicates deteriorating efficiency, or accumulation of assets not contributing to current production or an increase in the revenues.

Uniformity across the firms within the industry decreased throughout the test period. Especially after 1986, the decrease in uniformity can be seen more apparently.

There was no real change in the stability levels, except with reference to unusual instability in 1985. Asset turnover ratio within the industry experienced stability during the test period, except 1985.

The industry asset turnover ratio followed a "random walk" pattern throughout the test period. There was no evidence for a systematic pattern in the industry ratio values.

D. TURNOVER OF WORKING CAPITAL

1. Importance of the Ratio

The turnover of working capital ratio measures how effectively a company's working capital is used to generate and process sales. Purchasing and credit-policy decisions must be made wisely if unexpected serious cash shortages are to be avoided. This ratio continuously measures the complex relationship between buying and selling. The turnover of working capital ratio is calculated as follows:

$$\text{Turnover of working capital} = \frac{\text{Net sales}}{\text{Working capital}}$$

The best managerial goal may be to hold the ratio more-or-less constant after first determining what works best for the company. Although lower values may indicate inefficient use of funds, high values could make the company vulnerable in an adverse business climate.[Ref. 8, p.57]

2. Industry Condition

The condition of the industry was examined by analyzing the level of industry turnover of working capital ratio. The average ratio values were calculated and are plotted in Exhibit 5-9. The visual analysis indicates that there was a slight declining trend in the average ratio values throughout the test period.

In order to test the significance of the change, both ANOVA and t-tests were used. The test results are displayed in Table 5-5, upper panel.

The oneway ANOVA test was used to compare the means of each year's industry turnover of working capital ratio values. The F-value is 1.34. The null hypothesis of no difference can be rejected only at a 78% confidence level. This provides mild evidence that the year-to-year industry turnover of working capital ratio decreased throughout the test period.

A t-test was conducted to test the significance of differences in the average level of ratio values between the 1980s and 1990s. The t-value is 1.28, high enough to reject the null hypothesis of no difference at a 80% confidence level. This provides mild support that the industry turnover of working capital ratio changed significantly from the 1980s to 1990s.

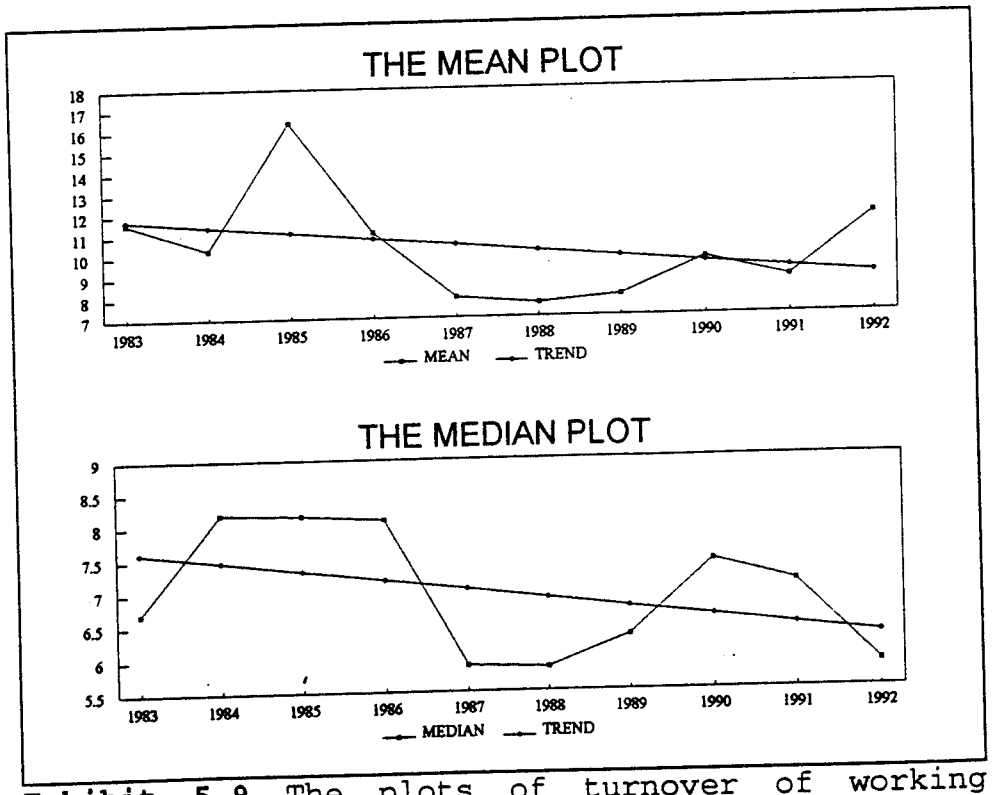

Exhibit 5-9 The plots of turnover of working capital

3. Uniformity Across Firms

The dispersion in the industry turnover of working capital ratio measures the uniformity across the firms within the industry. The variance in ratio levels was calculated and is plotted in Exhibit 5-10. The variation plot demonstrates a declining trend during the test period. This decline indicates that the degree of uniformity across the firms within the industry improved, except 1992. During 1992, the industry experienced high dispersion, and less uniformity.

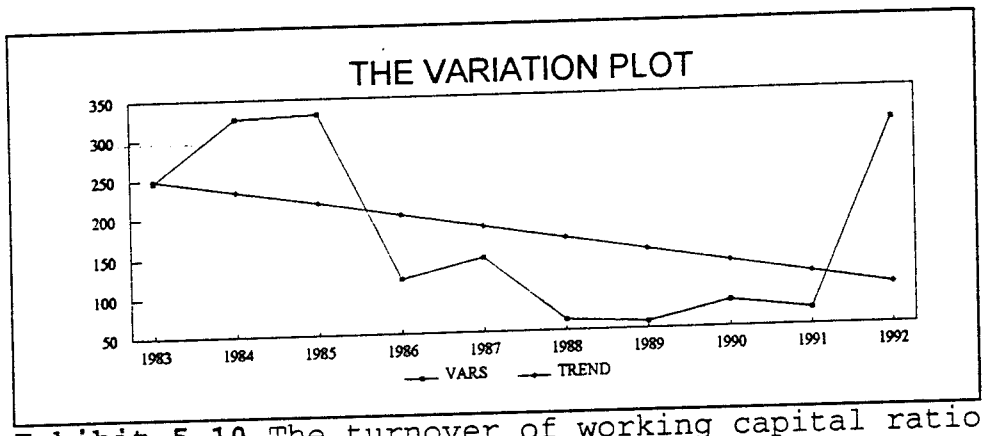

Exhibit 5-10 The turnover of working capital ratio

4. Stability Over Time

The absolute first annual differences of industry turnover of working capital ratios were examined in order to gain insight into the stability of the defense industry throughout the test period. For that reason the median of the absolute differences is plotted in Exhibit 5-11. The plot show a slight overall declining trend during the test period. The industry experienced instability between 1984 and 1988 (peaking in 1986), but stabilized by 1988. After 1988, the rate of change (instability) tended to increase only slightly.

The oneway ANOVA test was conducted to test the significance of the year-to-year changes (instability). The test results are in the bottom panel of Table 5-5. The F-value is 2.09, quite high. The null hypothesis of no

0difference is easily rejected at a 95% confidence level. This provides strong support for the finding that year-to-year differences in the rate of change (instability) in industry turnover of working capital ratio were significant.

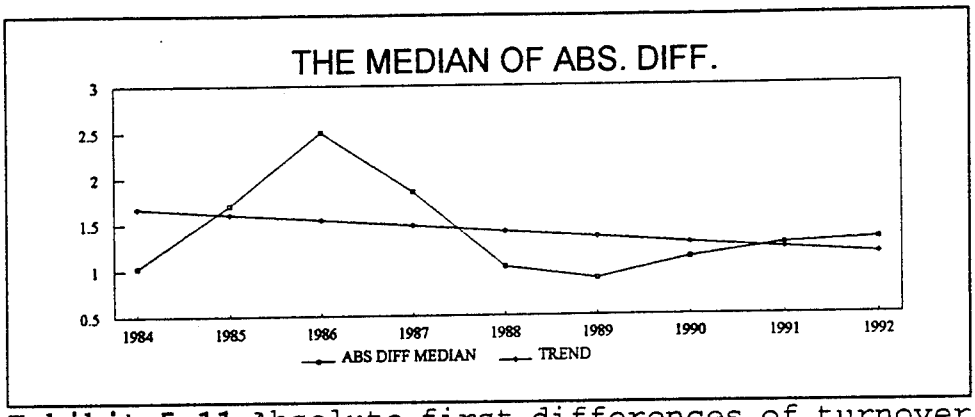

Exhibit 5-11 Absolute first differences of turnover of working capital

TESTS			TURNOVER OF WORKING CAPITAL
Ratio Level	ANOVA	F*	1.34
		p	0.214
	T Test	t*	1.28
		p	0.20
Abs. First Diff.	ANOVA	F*	2.09
		p	0.036
	T Test	t*	2.06
		p	0.042

Table 5-5 Statistical test results

A t-test was used to test for any significant change in the degree of stability between the early 80s and early 90s. The t-test results are displayed in Table 5-5, bottom panel. Since the t-value of 2.06 is quite high, the null hypothesis of no difference is rejected at a 95% confidence level. This provides strong evidence for the conclusion of a significant change in the industry stability level between 80s and 90s.

5. Time Series Pattern

The signed first annual differences for the turnover of working capital ratio were examined in order to detect the time series pattern for the industry. The median of annual differences was calculated and is plotted in Exhibit 5-12. The plot shows little systematic trend throughout the test period.

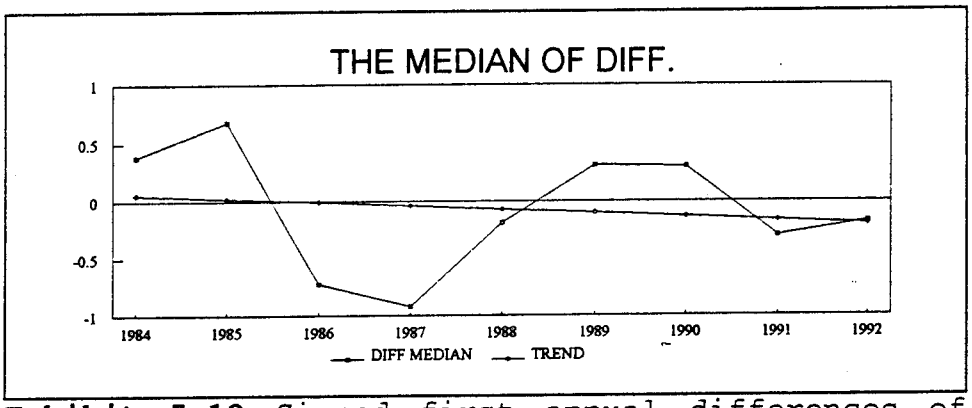

Exhibit 5-12 Signed first annual differences of turnover of working capital

The autocorrelations of annual differences were computed and are displayed in Table 5-6. The autocorrelation values consist of both positive and negative values. This indicates that changes in one year are not related to changes the next. This is consistent with a "random walk" pattern.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
-.611	-.576	.123	-.311	.143	.231	-.158	-.021

Table 5-6 Autocorrelations of first differences of turnover of working capital ratio

6. Summary

There was a slight declining trend in the industry turnover of working capital ratio values throughout the test period. The conducted statistical tests provided mild support for a significant deterioration in the industry condition.

Since the variation plot in Exhibit 5-10 shows a declining trend, the uniformity across firms within the industry improved throughout the test period.

There was a significant change in the industry stability during the test period. Instability peaked in 1986, but the industry stabilized by 1989. After 1989, the stability levels tended to decrease slightly.

Since the autocorrelation values show neither positive nor negative serial correlation, there was no apparent time series pattern. This indicates that changes in one year are not related to changes the next.

E. FIXED ASSET TURNOVER

1. Importance of the Ratio

The fixed asset turnover ratio compares net sales to fixed assets. Since the defense industry is capital intensive, the firms have substantial amount of resources invested in fixed assets. This ratio measures the efficiency in utilization of their plant capacity.[Ref. 8, p.90] The fixed asset turnover ratio is calculated as follows:

$$\text{Fixed asset turnover} = \frac{\text{Net sales}}{\text{Fixed assets}}$$

A decrease in the ratio may result from reduced sales or inefficient use of fixed assets. As long as the ratio shows an increasing trend, it can be concluded that the efficiency in plant capacity utilization is improving.

2. Industry Condition

The industry condition was explored by focusing on the level of industry fixed asset turnover ratio values. The mean and median of the ratio values were computed and are plotted in Exhibit 5-13. While the mean plot shows a slight declining trend, the median plot shows almost a constant trend during the test period. The visual analysis indicates that there is no change in the condition of the defense industry.

The following statistical tests were used to test the significance of change in the industry condition. The test results are listed in the top panel of Table 5-7.

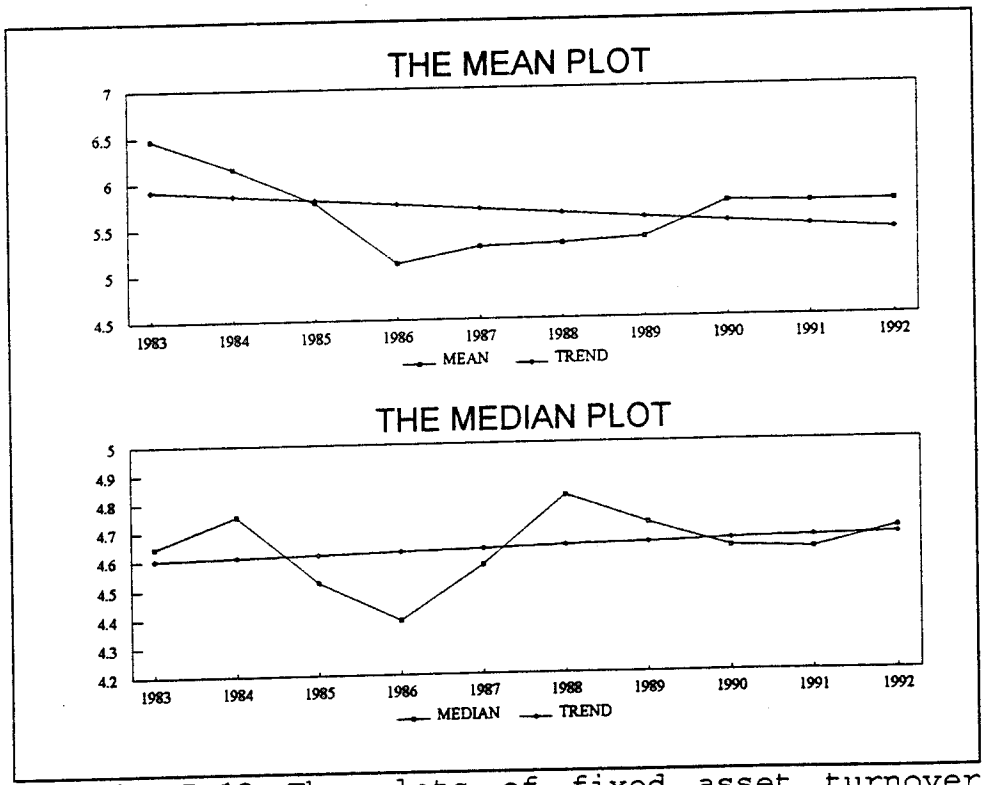

Exhibit 5-13 The plots of fixed asset turnover ratio

The oneway ANOVA test was conducted to see the significance of the successive year's change. The F-value is 0.29, quite low and insignificant. The null hypothesis of no change is strongly supported by p-value of 0.976. For that reason it is concluded that there is no significant change in the year-to-year industry fixed asset turnover ratio levels.

A t-test was used to see whether the industry condition changed significantly from the early 1980s to early 1990s. Since the t-value is quite low and insignificant, the null hypothesis of no difference is accepted, and it is concluded that there was no significant change in the industry condition from 80s to 90s.

TESTS			**FIXED ASSET TURNOVER**
Ratio Level	ANOVA	F*	0.29
		p	0.976
	T Test	t*	0.57
		p	0.57
Abs. First Diff.	ANOVA	F*	1.02
		p	0.417
	T Test	t*	0.56
		p	0.58

Table 5-7 Statistical test results

3. Uniformity Across Firms

The uniformity across firms was examined by focusing on the dispersion in the fixed asset turnover ratio values. The variance in the ratio values is plotted in Exhibit 5-14.

The variation plot shows a slight overall declining trend, and indicates some small increase in the degree of

uniformity across the firms within the industry. However, after 1988 the industry experienced increasing dispersion across firms. This increase indicates that the degree of uniformity across firms tended to decrease after 1988.

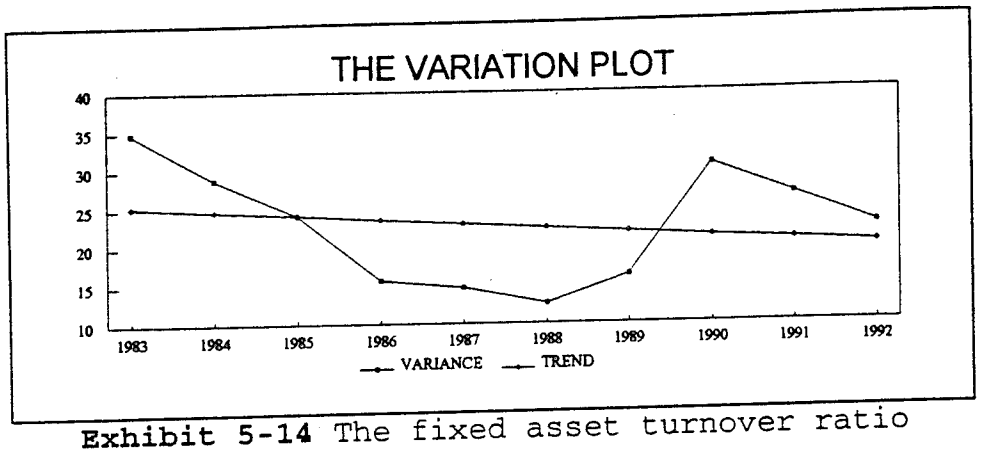

Exhibit 5-14 The fixed asset turnover ratio

4. Stability Over Time

The industry stability was examined by focusing on the absolute value of first annual differences in the fixed asset turnover ratio. The median of the absolute differences is plotted in Exhibit 5-15.

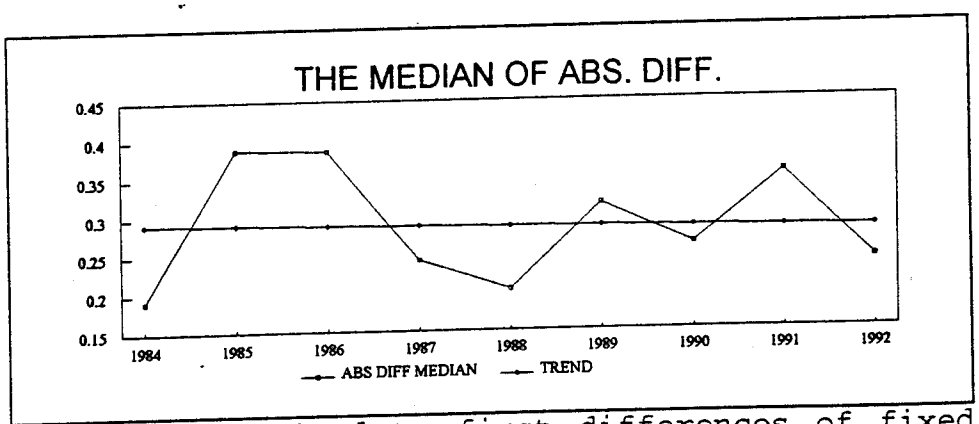

Exhibit 5-15 Absolute first differences of fixed asset turnover ratio

The plot shows almost a constant trend during the test

period. The industry experienced instability between 1984 and 1987, and stabilized by 1988. After 1988, instability tended to increase again, peaking in 1991.

The following statistical tests were used to test the significance of differences in the rate of change (instability) in the industry between 1983 and 1992, and the results are listed in Table 5-7, bottom panel.

The oneway ANOVA test was conducted in order to see the significance of the year-to-year differences. The F-value is quite low and insignificant. For that reason, the null hypothesis of no difference can not be rejected. Thus it is concluded that there was no significant difference in the rate of change in the year-to-year fixed asset turnover ratio values.

A t-test was used to test whether the industry stability levels changed significantly from 1980s to 1990s, or not. The t-value is too low to reject the null hypothesis. This provides no evidence for a significant difference (instability) in the industry between 80s and 90s.

5. Time Series Pattern

The time series pattern of the industry fixed asset turnover ratio was examined by focusing on the signed first annual differences. The median of first differences of ratio values is plotted in Exhibit 5-16. The plot does not show any inherent time series pattern.

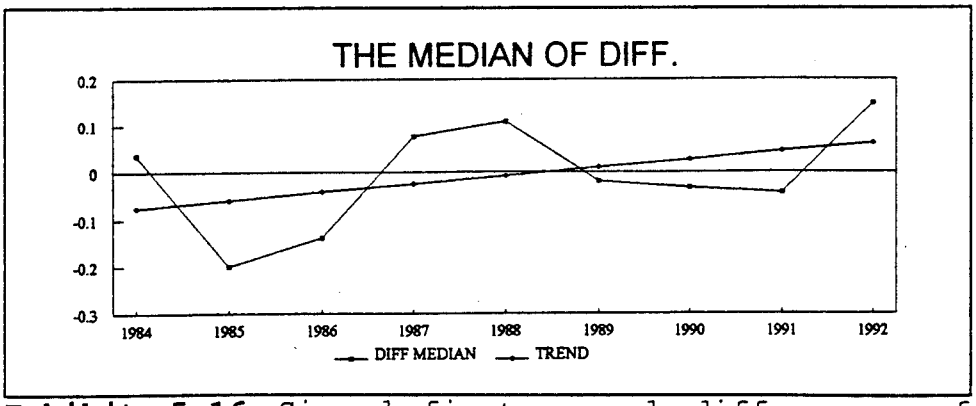

Exhibit 5-16 Signed first annual differences of fixed asset turnover ratio

Autocorrelations of first annual differences were computed and are displayed in Table 5-6. Since the autocorrelation values consist of both positive and negative values, changes in one year are not related to changes the next, evidence consistent with a random walk.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
.024	-.017	.058	.418	-.339	.072	-.579	.065

Table 5-8 Autocorrelations of first differences of fixed asset turnover ratio

6. Summary

Both visual and statistical analyses indicate that there is no significant change in the fixed asset turnover ratio values during the test period. The condition of the defense industry did not change from 80s to 90s.

Uniformity across the firms within the industry increased slightly during the test period. But the overall impression was one of no systematic trend.

The industry experienced some peak instability in 1985 and 1991. But there was no overall systematic pattern in the stability during the test period.

There was no apparent time series pattern in the industry fixed asset turnover ratio values during the test period. Since the autocorrelation values consist of both positive and negative values, changes in one year were not related to changes the next.

The industry fixed asset turnover ratio did not show any significant systematic change throughout the ten year period. It can be concluded that the efficiency in utilization of the industry plant capacity did not change significantly.

F. SUMMARY OF FINDINGS FOR EFFICIENCY RATIOS

Four different efficiency ratios were examined in order to gain insight into the efficiency pattern of the defense industry throughout the test period. In business, the managerial goal is to operate as efficiently as possible. For that reason, efficiency is a key success factor for the industry.

Overall, efficiency ratios did not show any consistent pattern. While asset turnover and turnover of working capital ratios were deteriorating, the fixed asset turnover ratio remained constant and the inventory turnover ratio improved. This inconsistency is not all that surprising. Firms could be efficient in the use of some resources and not in others. And different factors may affect the utilization of different classes of assets.

There were some years of relatively greater dispersion across the industry. Between 1986 and 1988 the industry experienced less dispersion in the ratio levels. However, there was no systematic pattern in uniformity across the firms within the industry during the test period.

Generally, the largest year-to-year changes in efficiency occurred between 1985 and 1986. Turnover ratios, except inventory turnover ratio, seemed more stable in the early 90s relative to the 80s. The inventory turnover ratio on the other hand, showed decreasing stability over time, especially after 1988.

The autocorrelation values of the four examined efficiency ratios were both positive and negative and generally insignificant. This indicates that there was a "random walk" pattern in the industry efficiency ratios. Changes in one year tend not to be related to changes the next.

VI. LIQUIDITY

A. INTRODUCTION

A corporation's liquidity is measured by its ability to raise cash from all sources. Liquidity ratios help statement users appraise a company's ability to meet its current obligations using its cash and current assets. These ratios compare current liabilities, which are the obligations falling due in the next 12 months, and current assets, which typically provide the funds to extinguish these obligations.[Ref. 11, p.173] The following ratios are examined in order to gain insight into the liquidity pattern of the defense industry between 1983 and 1992.

B. CURRENT RATIO

1. Importance of the Ratio

The current ratio is the best known measure of liquidity. The number of times current assets cover current liabilities is an important expression of the company's ability to meet obligations as they come due. The current ratio is determined by dividing the current assets by the current liabilities. The ratio formula is as follows:

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

The popular rule of thumb for the current ratio is two. Many consider this the minimum necessary for reliable cash flow. Much higher ratios could mean that management is not aggressive in finding ways to put current assets to work.[Ref. 8, p.52]

2. Industry Condition

The condition of the industry was examined by analyzing the level of industry current ratios. The average ratio values were calculated and are plotted in Exhibit 6-1. While

the mean plot shows almost a constant trend, the median plot shows a slight declining trend. This difference may be caused by extreme values in the data set. For that reason, the median plot draws more meaningful picture relative than the mean plot.

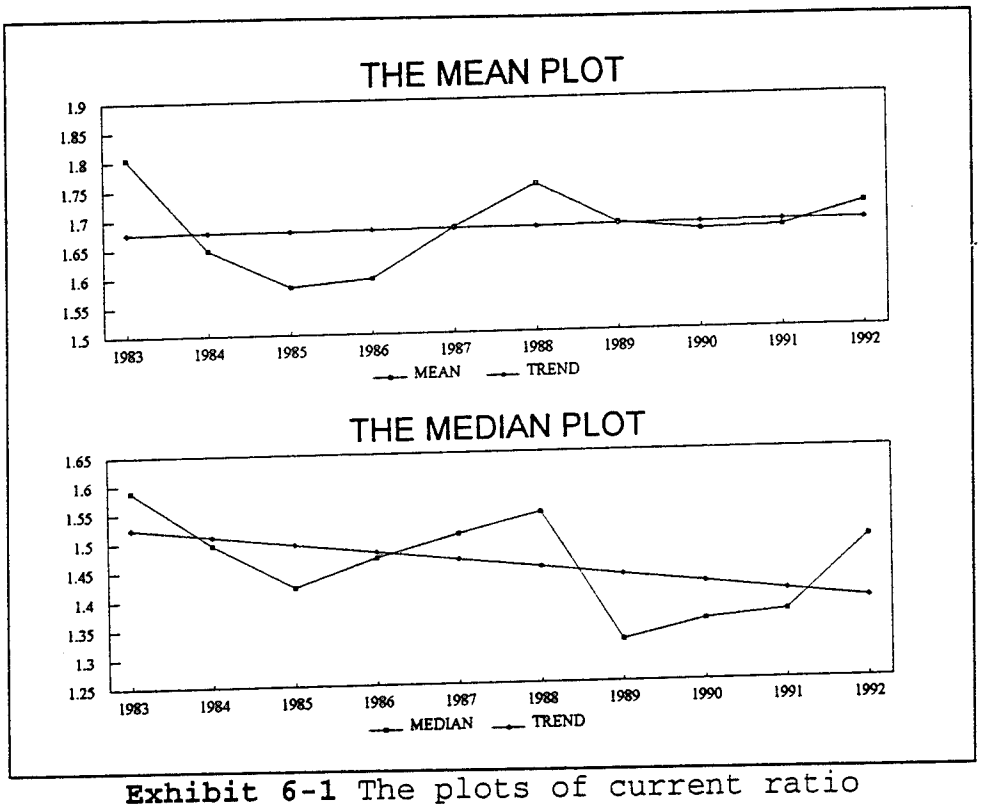

Exhibit 6-1 The plots of current ratio

In any case, the average current ratio in the industry is less than the generally expected value of two. During 1985 and 1989, the industry current ratio experienced its lowest values.

In order to test the significance of any change, the following statistical tests were conducted. Test results are listed in the upper panel of Table 6-1.

The oneway ANOVA test was used to compare the means of successive years' current ratio values. Since the F-value is

too low and insignificant, the null hypothesis cannot be rejected. Thus, it is concluded that there was no significant year-to-year change in the current ratio levels during the test period.

TESTS			CURRENT RATIO
Ratio Level	ANOVA	F*	0.25
		p	0.986
	T Test	t*	-0.07
		p	0.95
Abs. First Diff.	ANOVA	F*	1.09
		p	0.369
	T Test	t*	1.00
		p	0.32

Table 6-1 Statistical test results

A t-test was conducted to test whether or not the difference between the 80s and the 90s was significant. The t-value is too low to reject the null hypothesis of no change. For that reason, it is concluded that there was no significant change in the current ratio levels from the 80s to the 90s.

3. Uniformity Across Firms

The dispersion in current ratio values measures the uniformity across the firms within the industry. The variance of the ratio values is plotted in Exhibit 6-2 in order to display the dispersion across the industry firms.

The dispersion in the current ratio values showed an upward trend with a steep slope. This upward trend indicates a deterioration in the uniformity across the firms within the

industry throughout the test period. The degree of uniformity differs significantly from the 80s to the 90s.

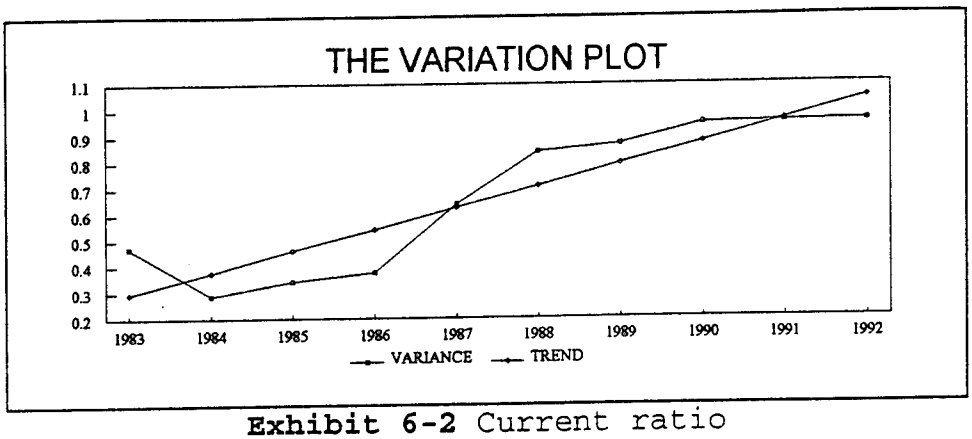

Exhibit 6-2 Current ratio

4. Stability Over Time

The absolute first annual differences of current ratio values were examined in order to gain insight into the stability of the defense industry throughout the test period. The median of the absolute differences was calculated and is plotted in Exhibit 6-3.

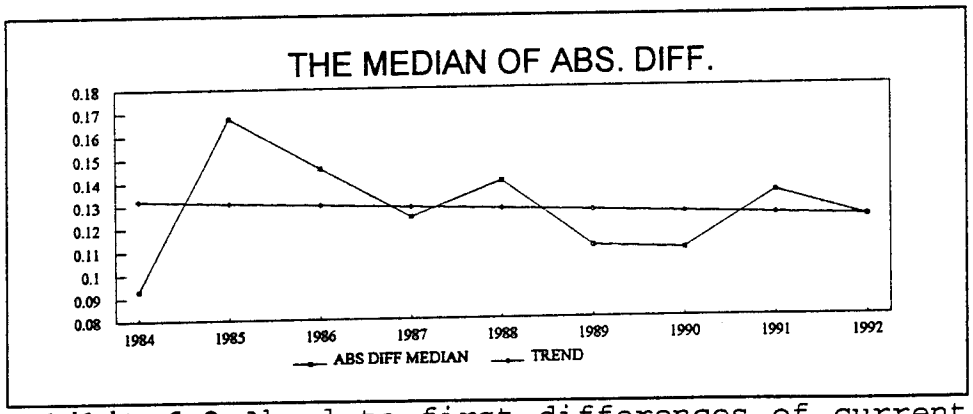

Exhibit 6-3 Absolute first differences of current ratio

The median plot shows a slight overall downward trend. The industry experienced a peak of instability in 1985. Since then, the stability levels tend to show some increase.

Visually the current ratio values appear more stable during the early 90s relative to the 80s.

The following statistical tests were used to examine the significance of differences in the rate of change (instability) in the industry current ratio throughout the test period. The test results are listed in Table 6-1, lower panel.

The oneway ANOVA test was conducted to see the significance of the differences in the successive year's stability. The F-value is not high enough to reject the null hypothesis of no difference. For that reason, it is concluded that there is no significant difference in the rate of change (instability) in the successive year's current ratio levels.

A t-test was used to examine the significance of the change in the stability between 1980s and 1990s. The t-value is quite low. Thus, the null hypothesis of no change is accepted and one must conclude that there is no significant difference in stability from the 1980s to the 1990s.

5. Time Series Pattern

The annual signed first differences of the current ratio were examined in order to detect the apparent time series pattern for the industry during the test period. The median of annual differences was calculated and is plotted in Exhibit 6-4. The plot does not show any apparent pattern in the ratio values.

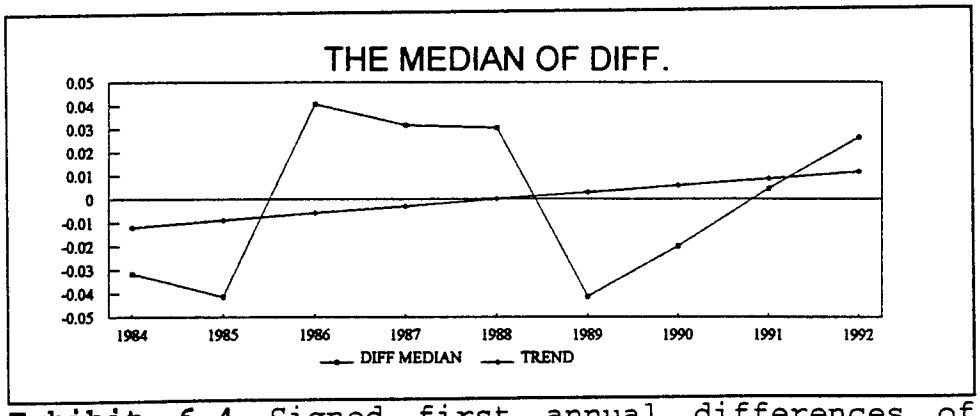

Exhibit 6-4 Signed first annual differences of current ratio

Autocorrelations of first annual differences were calculated and are listed in Table 6-2. There is no consistency in the sign of the autocorrelation values and generally they are insignificant. This indicates that changes in one year are not related to changes the next, evidence consistent with a "random walk" pattern.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
.282	-.456	-.155	.218	-.105	.066	.000	-.133

Table 6-2 Autocorrelations of first differences in the current ratio

6. Summary

The average current ratio values did not show any significant change during the test period. Even though the industry current ratio was less than the generally expected value of two, there was no significant change in the industry condition.

The dispersion in the industry current ratio values increased significantly throughout the test period. This indicates that there is an apparent deterioration in the degree of uniformity across the firms within the industry.

The industry experienced peak instability in 1985. Since then, the stability tended to increase. But statistical tests did not indicate that the apparent changes in stability were significant.

Changes in one year were not related to changes the next. This indicates that there was a "random walk" pattern in the industry current ratio values during the test period.

C. QUICK RATIO

1. Importance of the Ratio

This ratio is also called the acid test ratio. The quick ratio is perhaps the best measure of near term liquidity, because it deals only with those assets that can be converted to cash in a short time. The quick ratio is determined by dividing the current assets other than inventories by the current liabilities. The ratio formula is as follows:

$$\text{Quick ratio} = \frac{\text{Current assets - Inventories}}{\text{Current liabilities}}$$

A quick ratio between one-half and one is considered satisfactory for most businesses if there is no reason to believe that anything will slow the collection of receivables and no negative year-to-year trends are apparent.[Ref. 8, p.53]

2. Industry Condition

The average quick ratio levels were examined to analyze the condition of the industry during the test period. The mean and median of the ratio values were calculated and are plotted in Exhibit 6-5.

While the mean plot shows a slight upward trend, the median plot shows slight downward trend. This difference may be caused by extreme points and wide distribution in the data set. For that reason the median plot provides better measure of the condition, than the mean plot.

In order to test the significance of any change, the following statistical tests were conducted. Test results are listed in Table 6-3, upper panel.

The oneway ANOVA test was used to examine the significance of the year-to-year change in the industry quick ratio. The F-value is too low to reject the null hypothesis of no change. For that reason, one must conclude that there

is no significant change in the year-to-year quick ratio levels throughout the test period.

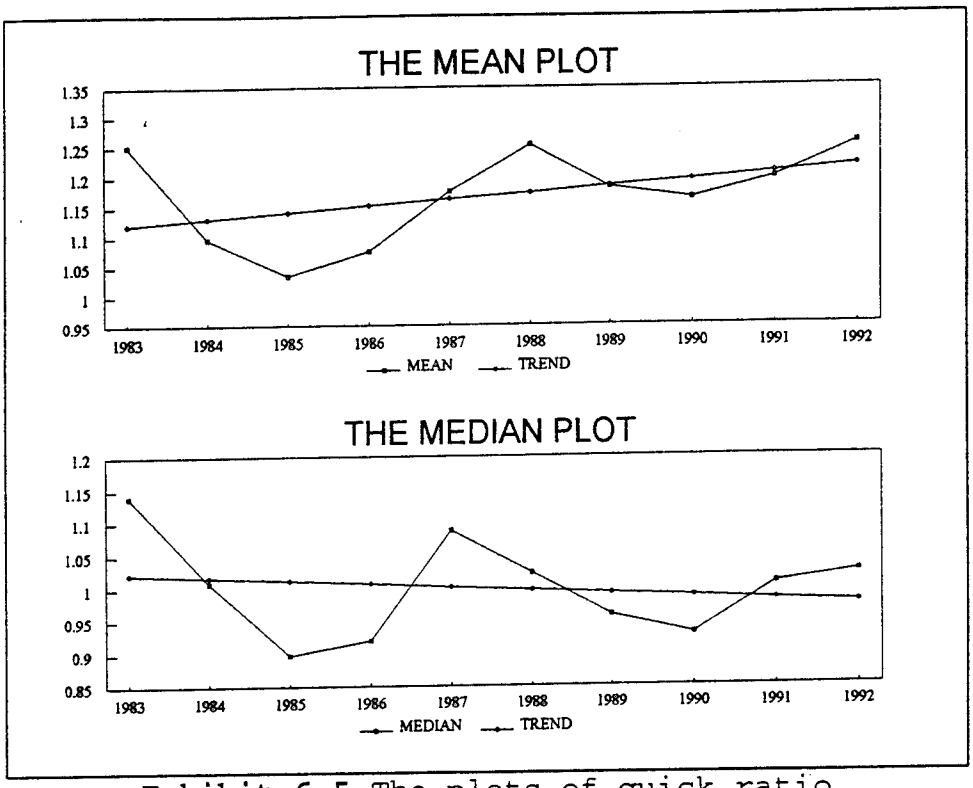

Exhibit 6-5 The plots of quick ratio

A t-test was conducted to test whether or not the ratio values changed significantly from the 80s to the 90s. Since the t-value is too low, the null hypothesis of no difference can not be rejected. Thus, it is concluded that there is no significant change in the quick ratio levels from the 80s to the 90s.

3. Uniformity Across Firms

The dispersion in the quick ratio values measures the uniformity across the firms within the industry. The variance of ratio values were computed and are plotted in Exhibit 6-6.

The variation plot shows that there is an increasing dispersion trend in the data set. This indicates that uniformity across the firms within the industry deteriorated

throughout the test period.

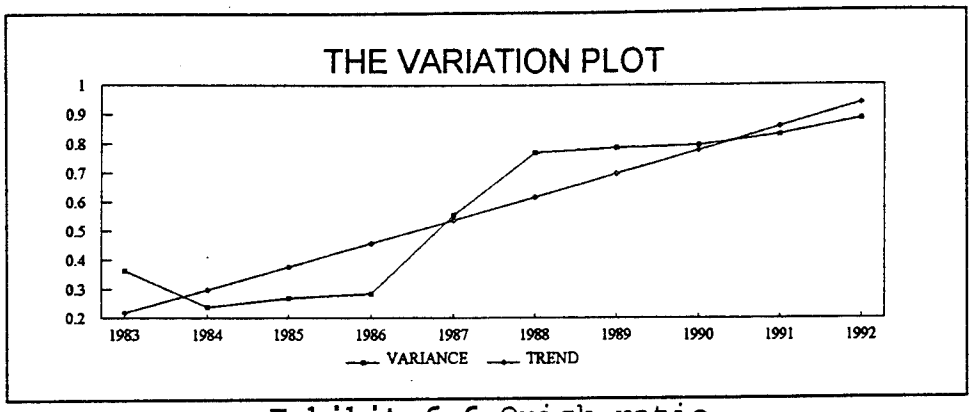

Exhibit 6-6 Quick ratio

TESTS			QUICK RATIO
Ratio Level	ANOVA	F*	0.39
		p	0.939
	T Test	t*	-0.77
		p	0.44
Abs. First Diff.	ANOVA	F*	1.51
		p	0.151
	T Test	t*	1.22
		p	0.23

Table 6-3 Statistical test results

4. Stability Over Time

Absolute first annual differences of the quick ratio were examined in order to analyze the industry stability during the test period. The median of the absolute differences is plotted in Exhibit 6-7.

The plot shows an overall decreasing trend in the

instability levels. The industry experienced peak instability in 1987. After then, the instability levels tended to decrease until 1990. In the early 90s the levels began to show an upward trend. However, there is no overall systematic pattern in the industry stability.

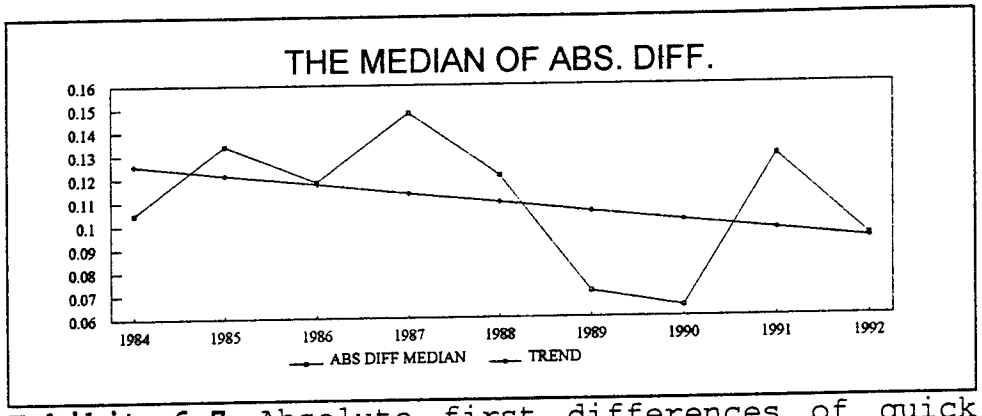

Exhibit 6-7 Absolute first differences of quick ratio

The following statistical tests were used to examine the significance of difference in the rate of change (instability) in the quick ratio values during the test period. The test results are displayed in Table 6-3, bottom panel.

The oneway ANOVA test was used to see whether or not the year-to-year differences in the rate of change in the quick ratio values were significant. The F-value is quite high. The null hypothesis of no difference can be rejected at an 84% confidence level. This provides mild evidence that the rate of change in quick ratio values differed significantly during the test period.

A t-test was used to examine the significance of the difference (instability) between the 80s and 90s. The t-value is not very high. The null hypothesis of no change can be rejected only at a 77% confidence level. This provides a very mild evidence that quick ratios were changing more rapidly during the 1980s when compared to the 1990s.

5. Time Series Pattern

The median of the signed first annual differences was calculated and is plotted in Exhibit 6-8 in order to display the apparent time series pattern of changes in the industry quick ratio. The median plot does not show any consistent pattern.

Autocorrelations of the signed first annual differences of the quick ratio were calculated and are listed in Table 6-4. Since the autocorrelation values consist of both positive and negative values, changes in one year are not systematically related to changes the next, evidence consistent with a random walk.

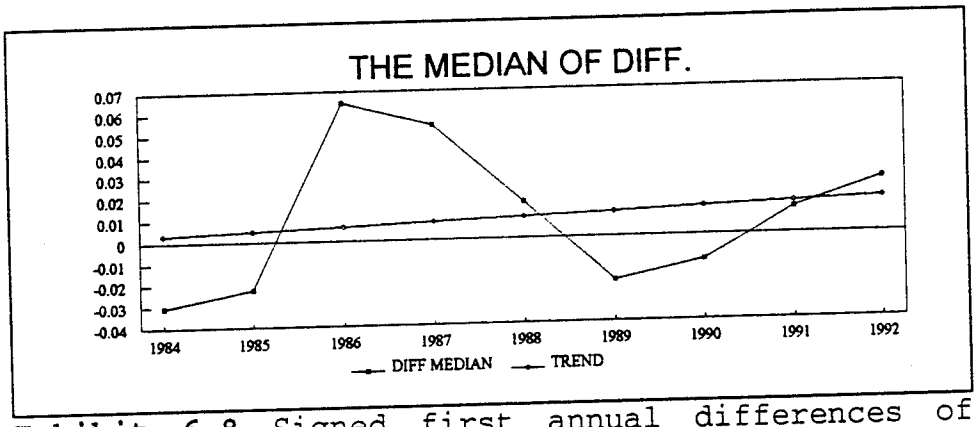

Exhibit 6-8 Signed first annual differences of quick ratio

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
.412	-.406	-.193	.285	-.319	.157	.041	-.079

Table 6-4 Autocorrelations of signed first differences in the quick ratio

6. Summary

The plots and statistical tests did not provide any evidence in favor of a change. For that reason, one may conclude that the industry liquidity as reflected in the quick ratio did not change significantly during the test period.

The variance plot for the quick ratio showed increasing dispersion. This indicates that the uniformity across the firms within the industry deteriorated throughout the test period.

The industry experienced peak instability in 1987. However, there was no systematic pattern in the industry stability throughout the test period.

Autocorrelation values consisted of both positive and negative values. Changes in one year were not related to changes the next. This provides evidence consistent with a "random walk" pattern.

D. CASH RATIO

1. Importance of the Ratio

The cash ratio is used to view the liquidity of a firm from an extremely conservative point of view. This view may be most relevant when the company has pledged its receivables and its inventory, or severe liquidity problems with inventory and receivables may be suspected. The cash ratio relates cash equivalents and marketable securities available to cover current liabilities. This ratio indicates the "last resort" liquidity of the firm if it must depend on cash equivalents and marketable securities. The cash ratio is computed as follows:

$$\text{Cash ratio} = \frac{\text{Cash + Marketable securities}}{\text{Current liabilities}}$$

The cash ratio indicates the immediate liquidity of the firm. A high cash ratio may indicate the firm is not using its resource cash to its best advantage; that cash should be put to work in the operations of the company. A cash ratio that is too low could indicate an immediate problem with paying bills.[Ref. 10, p.237]

2. Industry Condition

The condition of the industry was examined by focusing on the average cash ratio level. The mean and median of the ratio levels were calculated and are plotted in Exhibit 6-9. Both plots show a slight downward trend during the test period, indicating slight deterioration in the cash ratio. However there is no pattern consistent with some systematic change in the industry cash ratio.

The following statistical tests were used to examine the significance of any change in the industry condition between 1983 and 1992. The test results are listed in Table 6-5, top panel.

TESTS			CASH RATIO
Ratio Level	ANOVA	F*	2.96
		p	0.002
	T Test	t*	1.66
		p	0.098
Abs. First Diff.	ANOVA	F*	3.42
		p	0.001
	T Test	t*	2.48
		p	0.015

Table 6-5 Statistical test results

The oneway ANOVA test was conducted to examine the significance of any differences in yearly cash ratio levels. Since the F-value is high , the null hypothesis of no difference is rejected. This provides strong support for the finding that there was a significant difference in the year-

to-year industry cash ratio levels.

A t-test was used to test the significance of a change in the cash ratio levels between the 80s and 90s. The t-value is quite high. Thus the null hypothesis can be rejected at a 90% confidence level. This provides some evidence for the finding that cash ratio levels were higher in the 80s than the 90s.

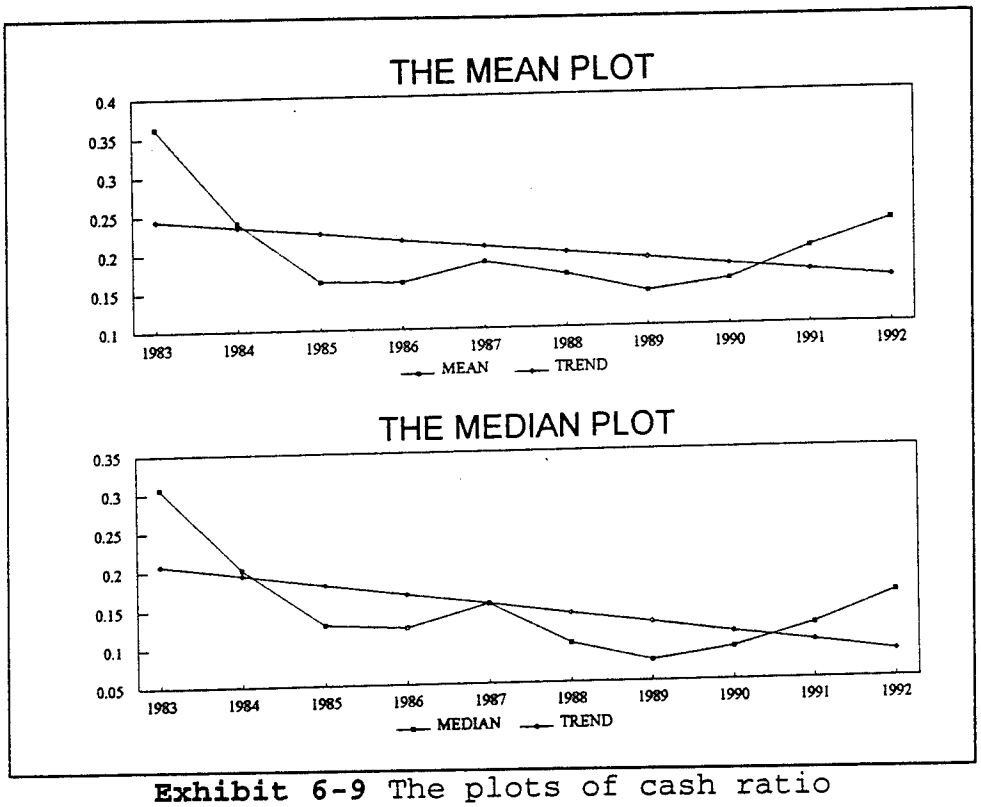

Exhibit 6-9 The plots of cash ratio

3. Uniformity Across Firms

The dispersion in the ratio levels measures the degree of uniformity in the industry. The variance of cash ratio levels was computed and is plotted in Exhibit 6-10.

The variation plot shows an overall level trend. However, the dispersion in the ratio values tended to be at a peak during 1983 and 1992. It can be concluded that there was no systematic trend in uniformity.

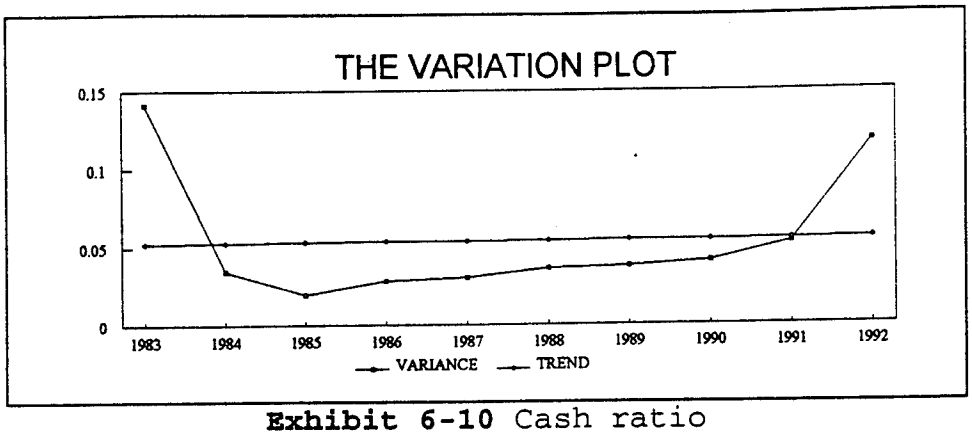

Exhibit 6-10 Cash ratio

4. Stability Over Time

The median of the absolute first differences was calculated and is plotted in Exhibit 6-11 in order to examine the stability of the industry during the test period. The median plot shows a declining overall trend. The industry experienced increasing stability during the test period.

The following statistical tests were used to examine the significance of differences in the rate of change (instability) in the industry cash ratio during the test period. The statistical test results are in Table 6-5, lower panel.

The oneway ANOVA test was conducted to see the significance of differences in the rate of year-to-year change in the ratio. Since the F-value is quite high, the null hypothesis of no difference can readily be rejected at a 95 % confidence level. This provides strong evidence for the finding that there was a significant difference in the rate at which ratio values changed during the test period.

A t-test was used to examine the significance of differences in the rate of change (instability) in the cash ratio between the 80s and the 90s. The t-value is too high. For that reason the null hypothesis of no change is easily rejected at a 95% confidence level. It is concluded that

there was a significant increase in stability between the 80s and the 90s.

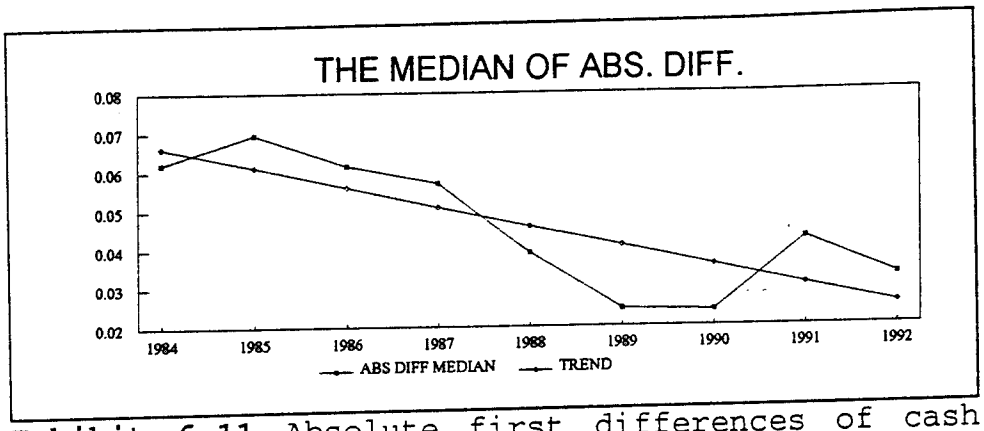

Exhibit 6-11 Absolute first differences of cash ratio

5. Time Series Pattern

The signed first annual differences were examined in order to gain insight into the apparent time series pattern of the industry cash ratio. The median of the signed differences is plotted in Exhibit 6-12.

Autocorrelations of signed first annual differences are listed in Table 6-6. Since negative autocorrelation values dominate, there is slight evidence of a "mean reverting" pattern.

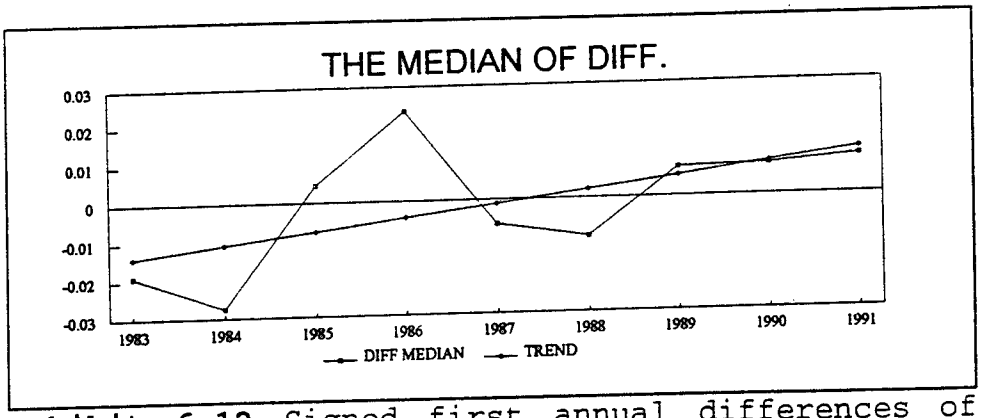

Exhibit 6-12 Signed first annual differences of cash ratio

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
.059	-.099	-.302	-.459	-.301	-.231	.403	-.013

Table 6-6 Autocorrelations of signed first differences in the cash ratio

6. Summary

The industry cash ratio levels show an overall downward trend throughout the test period. Statistical tests provided strong evidence for the finding that the cash ratio levels decreased significantly during the test period.

The dispersion among the industry firms followed an overall constant trend. There was no evidence that the industry had become more or less uniform with respect to cash ratios.

Both the variation plot and statistical tests provided strong evidence for the finding that there was a significant increase in the industry stability throughout the test period.

Negative autocorrelation values dominated among the signed first annual differences of the cash ratio. This indicates that there was mild evidence of a "mean reverting" pattern.

E. SUMMARY OF FINDINGS FOR LIQUIDITY RATIOS

Neither the current ratio nor the quick ratio indicated any change during the test period. The cash ratio however, was an exception, showing a significant decrease. The cash ratio is the most conservative measure for liquidity.

Uniformity across the firms within the industry decreased during the test period. Although the increase in dispersion was not readily apparent in the cash ratio, both the current ratio and quick ratio showed a considerable increase in dispersion.

Broadly, the three liquidity ratios tended to grow more stable over time but this increase in stability was not so

significant only for the current ratio.

While the cash ratio analysis provided some slight evidence of a "mean reverting" time series pattern, the current ratio and quick ratio appeared to be consistent with a random walk. Overall all there is little evidence to suggest that year-to-year changes in liquidity ratios were related.

VII. LEVERAGE

A. INTRODUCTION

Leverage ratios examine the relative contributions that the creditors and owners make to the financing of assets. Creditors expect owners to provide a fair share of equity funds to operate a firm. If the owners provide only a relatively small percentage of total funds, the creditors bear much more risk than they would if owners' equity was substantial. Leverage can be favorable to the owners if the firm is able to earn more on borrowed funds than it pays in interest. Leverage can be unfavorable, however, if the assets earn less than the interest cost of debt.[Ref. 16,p.6]

Leverage ratios measure the capital structure of the firm. Capital structure ratios provide some insight into tradeoffs made between return and long term risk. These ratios provide information about the business risk and the financial flexibility of the firm.[Ref. 3,p.56]

The extent to which a firm uses debt financing, or financial leverage, has three important implications: (1) By raising funds through debt, owners can maintain control of a firm with a limited investment. (2) Creditors look to the equity, or owner supplied funds, to provide a margin of safety. (3) If the firm earns more on investments financed with borrowed funds than it pays in interest, the return on the owners' capital is magnified or "leveraged." [Ref. 3,p.55]

B. EQUITY TO DEBT RATIO

1. Importance of the Ratio

This ratio is popular with lenders, compares the total of what is owed to what is owned. When the ratio exceeds 100%, it means that the capital provided by the stockholders exceeds that provided by the lenders. The equity to debt ratio is determined by dividing the stockholders' equity by the total liabilities. The ratio formula is as follows:

$$\text{Equity to debt ratio} = \frac{\text{Stockholders' equity}}{\text{Total liabilities}}$$

Owners seeking leverage in their capital structure prefer a low ratio. For each dollar invested by creditors, the company is able to buy more assets, presumably leading to increased sales and a higher return on investment. Lenders, on the other hand, prefer to see a high ratio as insurance that the company is able to repay its debts. The higher the debt, the greater the risk that the company will find itself in trouble if sales cannot be maintained at normal levels.

2. Industry Condition

The industry condition was explored by focusing on the level of equity to debt ratio values in the industry. The mean and median of ratio values were calculated and are plotted in Exhibit 7-1. Both of the mean and median plots of the equity to debt ratio show a downward trend. This is caused by either increasing debt or decreasing owners' equity. In either case the riskiness in the industry increased. Indeed, there is a visible decrease in the ratio levels between the 80s and 90s.

Both ANOVA and t-tests were used to examine the significance of the change in the industry condition. The test results are in Table 7-1, upper panel.

The oneway ANOVA test was conducted to test the significance of year-to-year differences. The F-value is high enough to reject the null hypothesis of no change. For that reason, one can conclude that there was a significant difference in ratio levels across the years.

A t-test was used to see whether the industry condition changed significantly from the 80s to the 90s. The t-value is also quite high. The null hypothesis of no change is readily rejected at a 99% confidence level. This provides strong evidence of a significant decrease in the equity to debt ratio

levels from the 80s to the 90s.

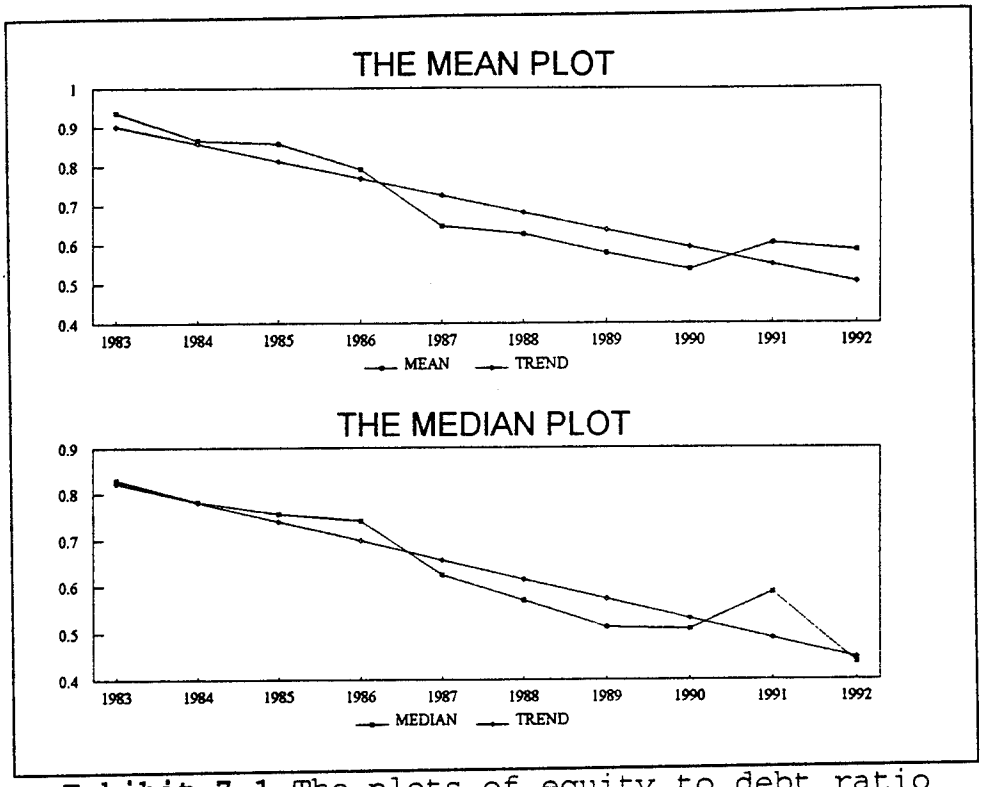

Exhibit 7-1 The plots of equity to debt ratio

TESTS			EQUITY TO DEBT
Ratio Level	ANOVA	F*	4.01
		p	0.000
	T Test	t*	5.37
		p	0.000
Abs. First Diff.	ANOVA	F*	1.27
		p	0.25
	T Test	t*	0.65
		p	0.52

Table 7-1 Statistical test results

3. Uniformity Across Firms

Dispersion in the equity to debt ratio measures the uniformity across firms. The variance in ratio values was calculated and is plotted in Exhibit 7-2. The plot shows an increasing dispersion during the test period. This indicates that the degree of uniformity across the firms within the industry deteriorated throughout the ten year test period.

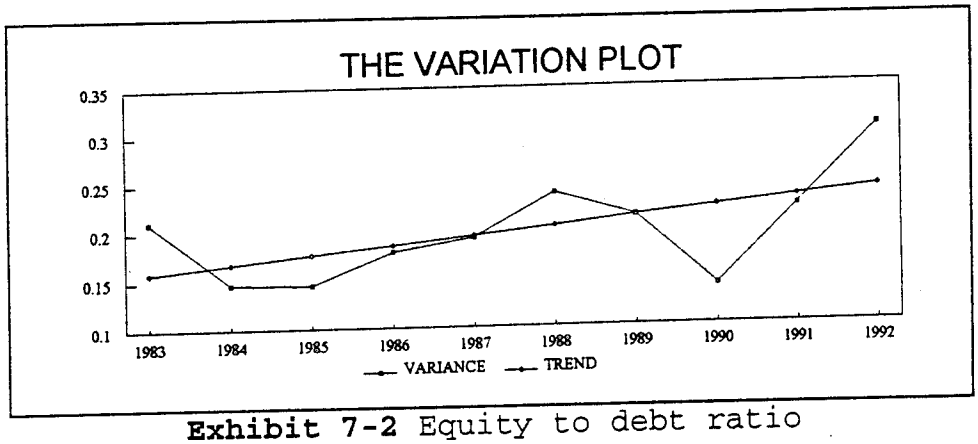

Exhibit 7-2 Equity to debt ratio

4. Stability Over Time

Absolute first annual differences of the equity to debt ratio were examined in order to gain insight into stability. The median of the absolute differences is plotted in Exhibit 7-3. The plot shows an overall declining trend in instability. The industry experienced generally increasing stability as the test period progressed. After 1989, the stability tended to deteriorate slightly. However there is no consistent pattern in stability.

The oneway ANOVA test was used to test the significance of differences in the rate of change (instability) in the industry during the test period. The results are in the bottom panel of Table 7-1. The F-value is 1.27. The null hypothesis of no difference can be rejected only at a 75% confidence level. This provides little evidence for the finding that there is significant difference in the year-to-

year rate of change in the equity to debt ratio values.

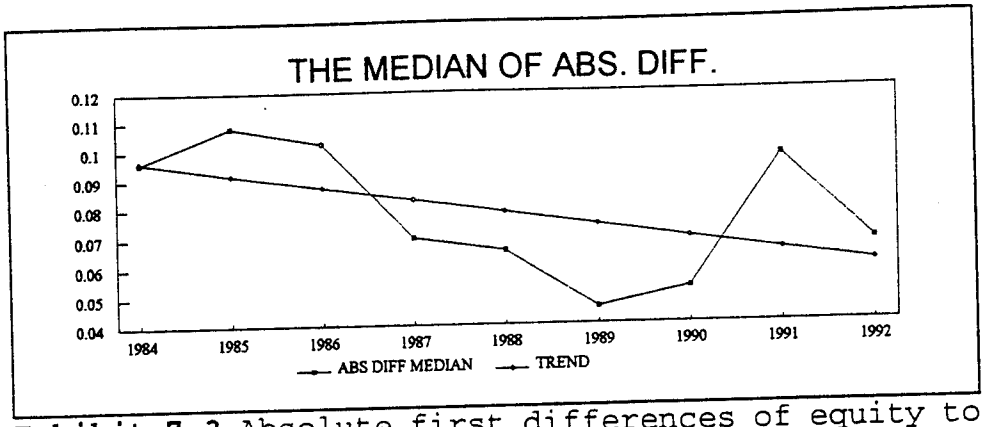

Exhibit 7-3 Absolute first differences of equity to debt ratio

A t-test was conducted to see whether or not the industry stability levels changed significantly from the 1980s to the 1990s. Findings are displayed in Table 7-1, bottom panel. The t-value is too low to reject the null hypothesis of no change. This provides no evidence for a significant difference (instability) in the industry between the 80s and the 90s.

5. Time Series Pattern

The time series pattern of the equity to debt ratio was examined by focusing on the signed first annual differences of this ratio. The median of the first differences is plotted in Exhibit 7-4. The plot does show some tendency toward alternating positive and negative values, consistent with an adjustment toward some norm.

Autocorrelation values of the first annual differences of the equity to debt ratio were calculated and are listed in Table 7-2. Since the autocorrelation values consist of both negative and positive numbers and are generally insignificant, changes in one year are not related to changes the next. This provides evidence consistent with a "random walk" pattern.

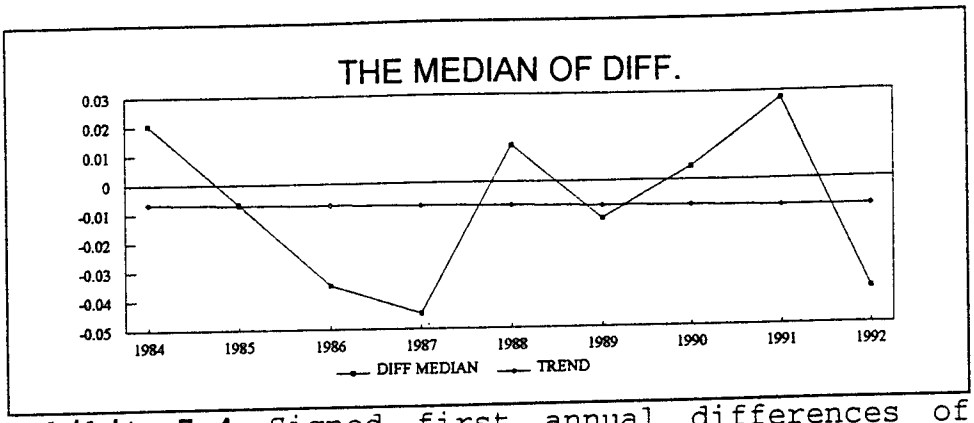

Exhibit 7-4 Signed first annual differences of equity to debt ratio

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
-.352	-.008	-.408	.059	-.319	-.242	.156	.060

Table 7-2 Autocorrelations of the first signed differences in the equity to debt ratio

6. Summary

There was a significant decrease in the industry equity to debt ratio levels during the test period. This was caused by either increasing debt or decreasing owners' equity. In either case the riskiness of the industry firms increased. Indeed, there was a visible decrease in the ratio levels from the 80s to the 90s.

The industry experienced increasing dispersion among the industry firms during the test period. This indicates that the degree of uniformity across the firms within the industry deteriorated throughout the ten year test period.

There is no significant change in stability throughout the test period. The industry experienced similar instability between the 1980s and the 1990s.

There was no apparent time series pattern in the industry. Changes in one year were not related to changes the next. This is consistent with a "random walk" pattern.

C. EQUITY TO ASSET RATIO

1. Importance of the Ratio

The equity to asset ratio is another way of measuring the relative mix of funds provided by owners and creditors. The equity to asset ratio relates total assets to stockholders' equity. This ratio is an indication of the degree to which management has financed the company's asset investments with nonownership capital.[Ref. 11,p.176] The equity to asset ratio was calculated as follows:

$$\text{Equity to asset ratio} = \frac{\text{Stockholders' equity}}{\text{Total assets}}$$

This ratio provides insight into the capital structure of the industry firms. High ratio values indicate low risk.

2. Industry Condition

Average equity to asset ratio levels were examined in order to analyze the industry condition between 1983 and 1992. Both the mean and median were calculated and are plotted in Exhibit 7-5. Both plots show an overall declining trend during the test period. The ratio of equity to total assets deteriorated from 45% to 32%. This indicates an increasing riskiness in the industry.

In order to test the significance of the change in the industry condition, the following statistical tests were conducted. The test results are in Table 7-3, top panel.

The oneway ANOVA test was used to examine the significance of the year-to-year differences in the equity to asset ratio values. The F-value is high enough to reject the null hypothesis of no difference. Thus, it is concluded at a 95% confidence level that there was a significant difference in the industry condition during the test period.

A t-test was conducted to see whether or not the industry condition changed significantly from the 80s to the 90s. The

t-value is 6.28, which is quite high. The null hypothesis of no change is readily rejected at a 95% confidence level. This provides strong evidence for the finding that there is a significant decline in the ratio and increase in the riskiness of the industry condition between the 1980s and the 90s.

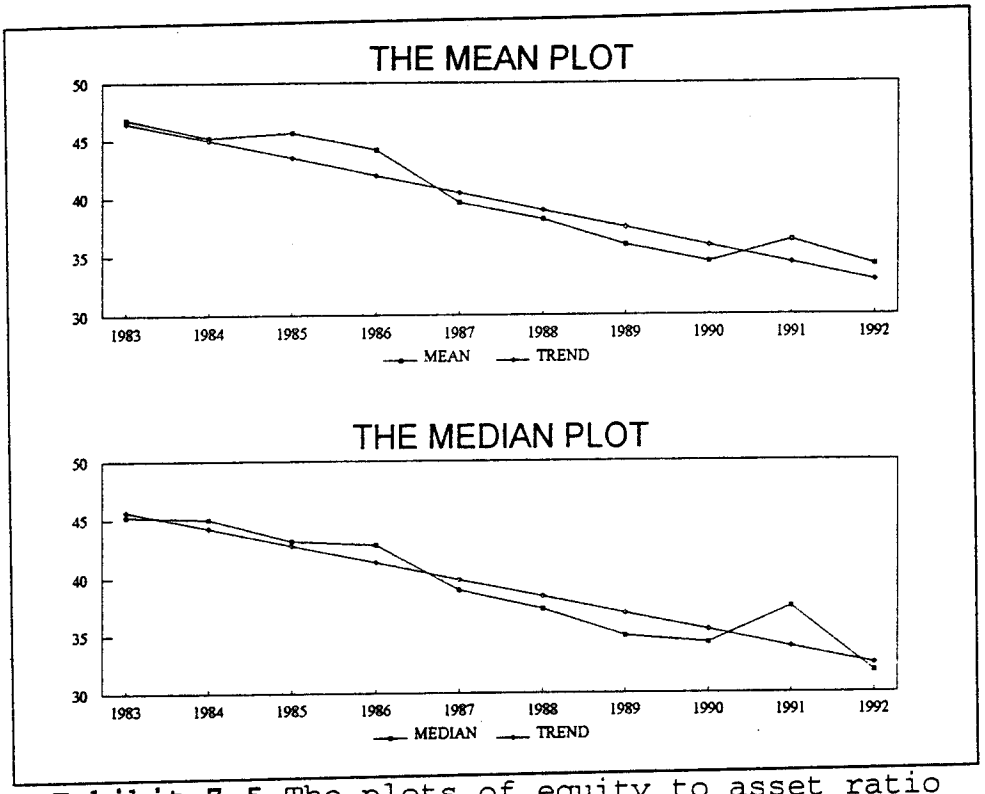

Exhibit 7-5 The plots of equity to asset ratio

3. Uniformity Across Firms

Dispersion in the equity to asset ratio was examined to measure uniformity across firms. The variance in the ratio values was calculated and is plotted in Exhibit 7-6. The variation plot shows an increasing overall trend during the test period. This provides evidence in favor of the decrease in uniformity across the firms within the industry between the 80s and the 90s.

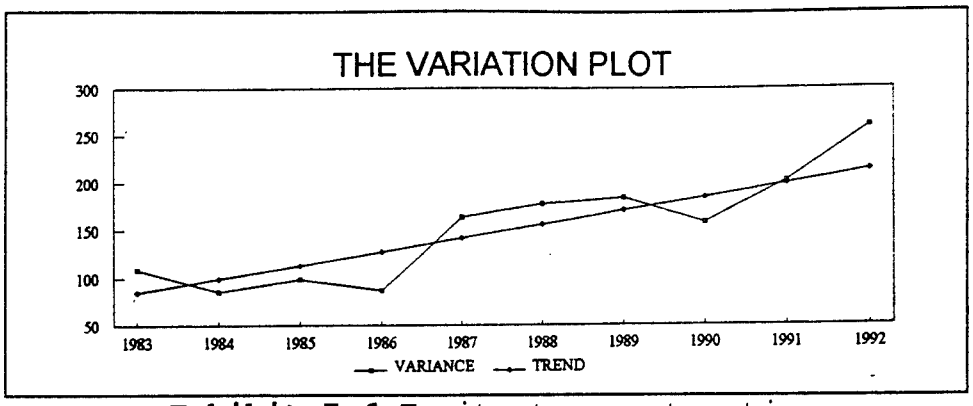

Exhibit 7-6 Equity to asset ratio

TESTS			EQUITY TO ASSET
Ratio Level	ANOVA	F*	5.38
		p	0.000
	T Test	t*	6.28
		p	0.000
Abs. First Diff.	ANOVA	F*	0.79
		p	0.609
	T Test	t*	-0.32
		p	0.75

Table 7-3 Statistical test results

4. Stability Over Time

Absolute first annual differences of the equity to asset ratio were examined to analyze the stability of the industry between 1983 and 1992. The median of the absolute differences of the ratio values is plotted in Exhibit 7-7. The plot shows overall increasing instability throughout the test period. The industry experienced a peak of instability in 1986 which

stabilized in 1989. After than, the instability of the industry tended to increase again with 1991 being another peak. The 90s values were more unstable relative to the 80s values. However, there is no consistent pattern in stability.

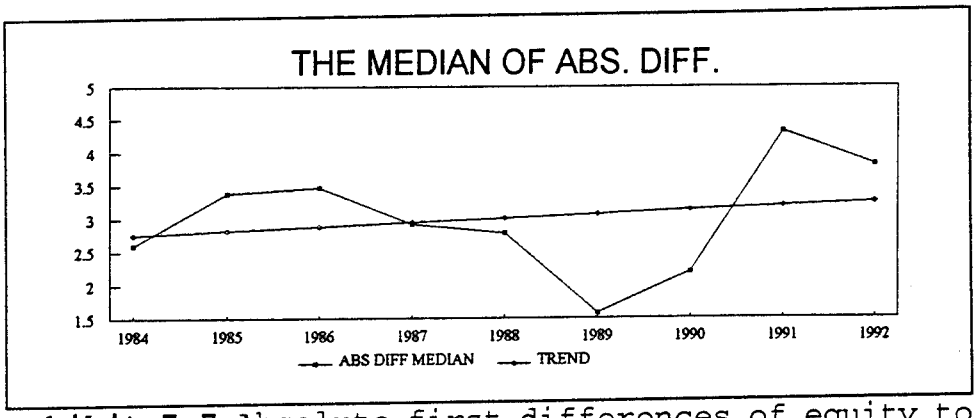

Exhibit 7-7 Absolute first differences of equity to asset ratio

Statistical tests were conducted to see whether or not differences in the rate of change (instability) were significant. The findings are in Table 7-3, bottom panel.

The oneway ANOVA test was used to examine the significance of year-to-year differences in the rate of change (instability) in the industry. The F-value is quite low and insignificant. The null hypothesis of no difference is accepted and one may conclude that there was no significant difference in the rate of change in the equity to asset ratio values during the test period.

A t-test was conducted to test the significance of change in industry stability between the early 80s and the early 90s. The t-value is -0.32, low and insignificant. The null hypothesis of no difference is accepted and it is concluded that there was no significant difference (instability) in the industry between the 80s and the 90s.

5. Time Series Pattern

The time series pattern of the equity to asset ratio was explored by focusing on the signed first annual differences. The median of the signed differences of the ratio values is plotted in Exhibit 7-8. The plot shows almost a level trend during the test period with first differences tending to alternate between positive and negative values. This is suggestive of an adjustment process toward some normal value, i.e., a mean reverting pattern.

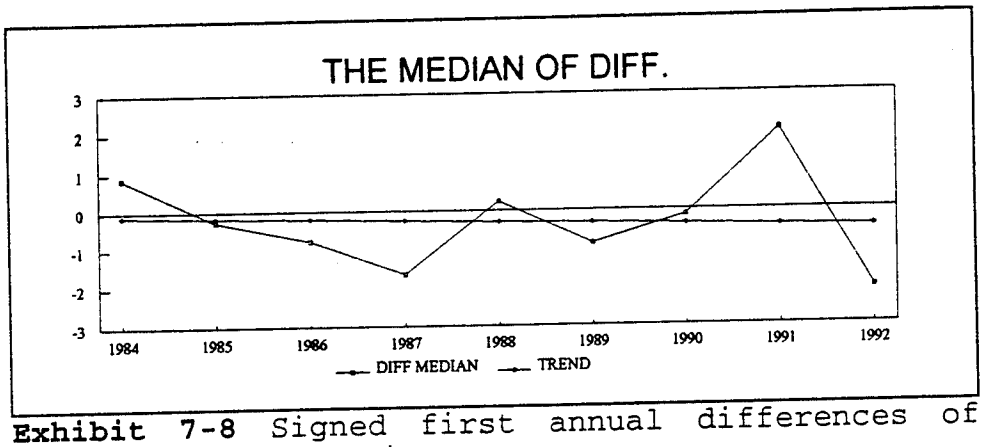

Exhibit 7-8 Signed first annual differences of equity to asset ratio

Autocorrelation values of the first annual differences of the equity to asset ratio were calculated and are listed in Table 7-4. Since the autocorrelation values consist of both negative and positive numbers and are generally insignificant, changes in one year are not related to changes the next. This provides evidence consistent with a "random walk" pattern.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
-.356	-.199	.046	-.127	-.229	-.273	.099	-.021

Table 7-4 Autocorrelations of the first signed differences in the equity to asset ratio

6. Summary

The equity to asset ratio levels declined significantly throughout the test period. The degree to which management financed asset investments with nonownership capital increased during that time. This indicates increasing riskiness within the industry.

The increasing dispersion in the ratio values during the test period provides evidence of a decrease in uniformity across firms within the industry.

The instability of the ratio tended to increase after 1989. However, there was no evidence of a consistent systematic pattern.

The autocorrelation of the first differences provided evidence consistent with a "random walk" time series pattern for the ratio.

D. DEBT RATIO

1. Importance of the Ratio

The ratio of total debt to total assets, generally called the debt ratio, measures the percentage of funds provided by creditors. The ratio is calculated as follows:

$$\text{Debt ratio} = \frac{\text{Current liabilities + L/T debt}}{\text{Total assets}}$$

Creditors prefer low debt ratios, because the lower ratio, the greater the cushion against creditor's losses in the event of liquidation. Owners, on the other hand, can benefit from leverage because it magnifies earnings. Firms with relatively high debt ratios have higher expected returns, however, they are exposed to higher risk. Thus, firms with low debt ratios are less risky, but they also forgo the opportunity to leverage up their return on equity.[Ref. 3,p.56]

2. Industry Condition

Average debt ratio levels were examined to gain insight into the industry condition. Both the mean and median of the ratio levels were calculated and are plotted in Exhibit 7-9. Both plots show increasing debt levels throughout the ten year test period. There is also an apparent increase in the industry debt ratio levels from the 80s to the 90s.

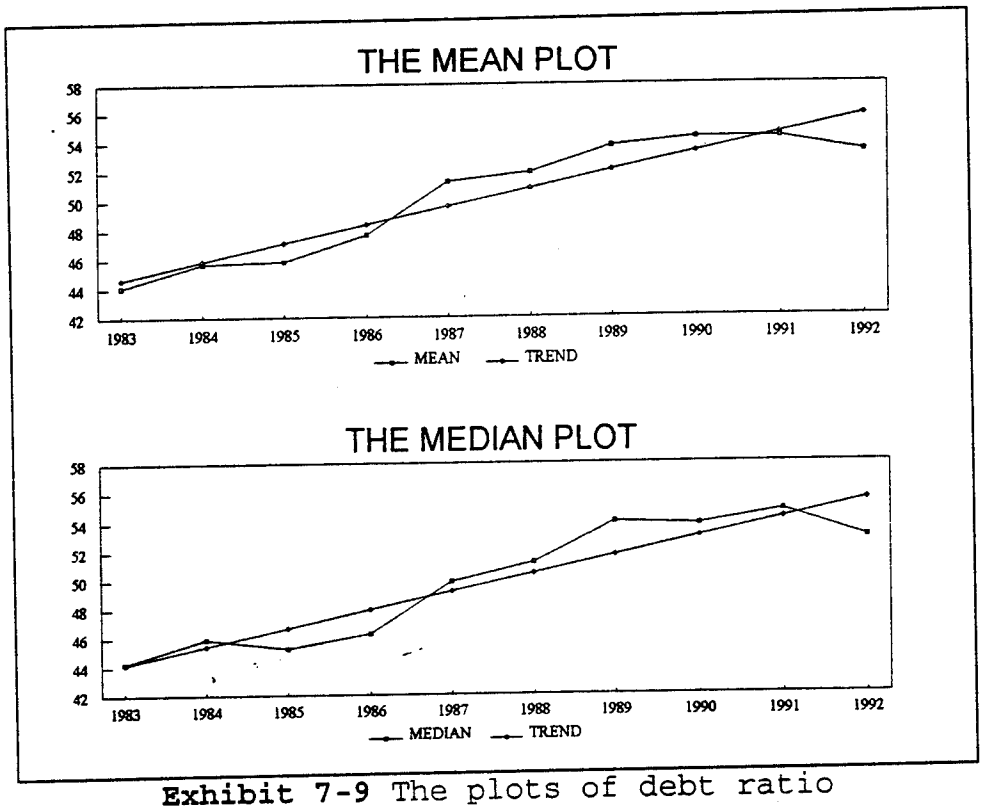

Exhibit 7-9 The plots of debt ratio

In order to test the significance of the change, following statistical tests were conducted. The test results are in Table 7-5, top panel.

The oneway ANOVA test was used to compare differences between the yearly ratio levels. The F-value is 3.36, high enough to reject the null hypothesis of no change. Therefore, it is concluded that there was a significant difference in the industry debt ratio levels during the test period.

A t-test was used to see whether or not the change in the industry condition between the early 80s and the early 90s was significant. The t-value is high and significant. This provides strong evidence for the finding that there was an increase in the industry debt ratio levels between the 80s and the 90s.

TESTS			DEBT RATIO
Ratio Level	ANOVA	F^*	3.36
		p	0.001
	T Test	t^*	-5.43
		p	0.000
Abs. First Diff.	ANOVA	F^*	1.99
		p	0.047
	T Test	t^*	0.58
		p	0.56

Table 7-5 Statistical test results

3. Uniformity Across Firms

Dispersion in the debt ratio levels measures the degree of uniformity within the industry. The variance in the ratio values was calculated and is plotted in Exhibit 7-10. The variation plot shows an overall increasing dispersion trend throughout the test period. This provides evidence that the degree of uniformity across the firms within the industry deteriorated.

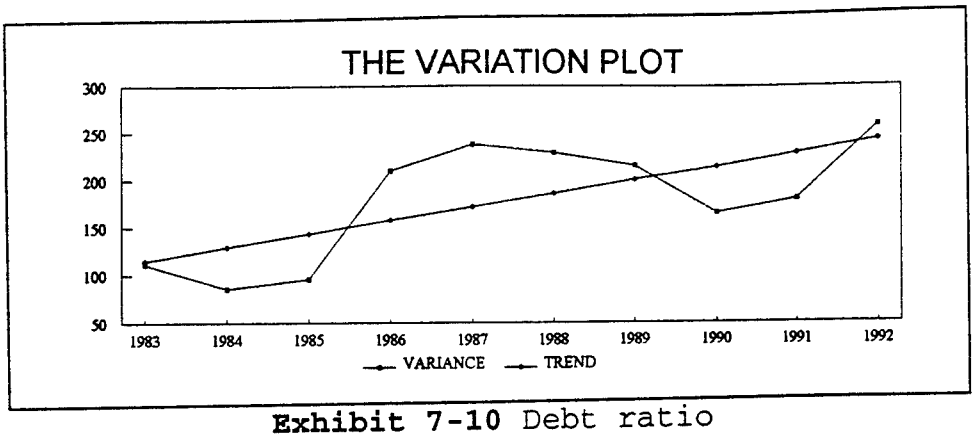

Exhibit 7-10 Debt ratio

4. Stability Over Time

Absolute first annual differences of the industry debt ratio were examined in order to gain insight into the stability of the ratio. The median of absolute differences is plotted in Exhibit 7-11. The plot shows an overall slight declining trend. The industry experienced peaking instability in 1987, and tended to be more stable after 1987.

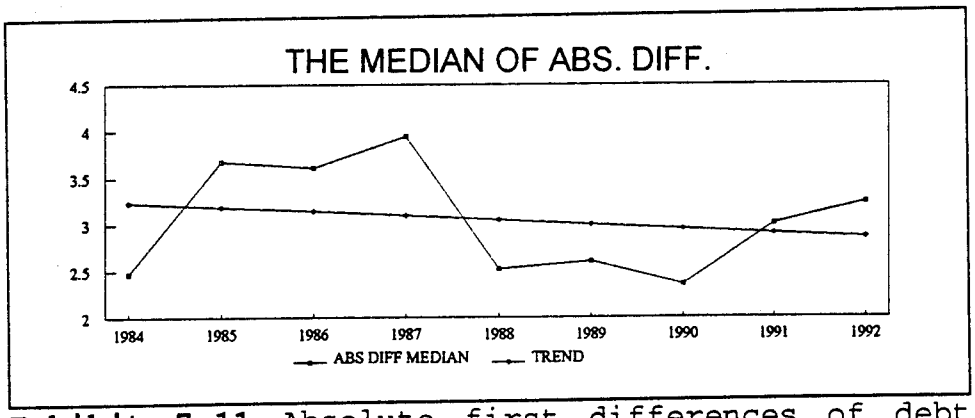

Exhibit 7-11 Absolute first differences of debt ratio

Statistical tests were conducted to test the significance of differences in the rate of change in the debt ratio. The test results are displayed in Table 7-5, bottom panel.

The oneway ANOVA test was used to see whether or not the

year-to-year differences in the rate of change (instability) in the industry debt ratio levels were significant. The F-value is 1.99, quite high. The null hypothesis of no difference is readily rejected at a 95% confidence level. This provides strong evidence for the finding that stability of the ratio varied significantly during the ten year test period.

A t-test was conducted to examine the significance of the difference (instability) in the rate of change of debt ratio levels between the early 80s and the early 90s. The t-value is 0.56, too low to reject the null hypothesis of no difference. For that reason, it is concluded that there was no significant difference in the industry stability between the 80s and the 90s.

5. Time Series Pattern

Time series pattern of the debt ratio was explored by focusing on the signed first annual differences of the debt ratio. The median of the signed differences is plotted in Exhibit 7-12. The plot does not indicate any consistent systematic pattern.

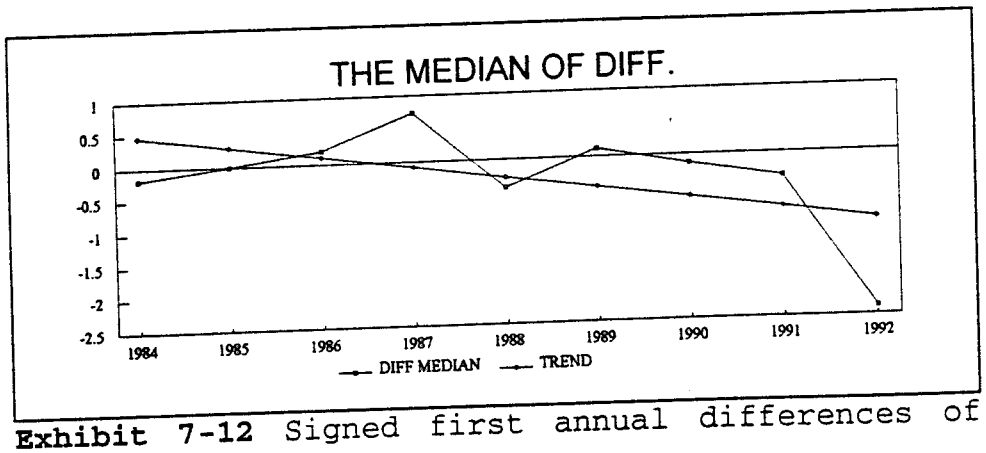

Exhibit 7-12 Signed first annual differences of debt ratio

Autocorrelation values of the first annual differences of the debt ratio were calculated and are listed in Table 7-2.

Since the autocorrelation values consist of both negative and positive numbers and are generally insignificant, changes in one year are not related to changes the next. This provides evidence consistent with a "random walk" pattern.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
-.203	-.058	-.217	.012	-.272	-.169	.139	-.155

Table 7-6 Autocorrelations of the first signed differences in the debt ratio

6. Summary

The industry debt ratio increased significantly during the ten year test period. Increasing debt ratios indicate that the defense firms were exposed to increasing risk.

The debt ratio levels increased from 45% to 55% in ten years. This means that creditors have supplied more than half the firms' total financing in the defense industry.

The industry experienced overall increasing dispersion in the debt ratio during the ten year test period. This provides evidence for the finding that the degree of uniformity across the firms within the industry deteriorated.

Evidence on the stability of the debt ratio was mixed, with the ratio being more stable in some year and less in others, but with no overall systematic pattern.

There was no apparent time series pattern in the industry. Changes in one year were not related to changes the next. This is consistent with a "random walk" pattern.

E. RETAINED EARNINGS TO ASSET

1. Importance of the Ratio

The retained earnings to asset ratio measures the portion of funds provided by the undistributed earnings of the company. The ratio is calculated as follows:

$$\text{Retained earnings to asset} = \frac{\text{Retained earnings}}{\text{Total assets}}$$

Retained earnings are built up over time as the firm saves a part of its earnings rather than paying all earnings out as dividends. High ratios are favorable, since they indicate that the company finance its assets with the earned funds instead of funds generated mainly by selling stock.[Ref. 3,p.38]

2. Industry Condition

The average level of the retained earnings to asset ratio was examined in order to analyze the industry condition. The mean and median of the ratio levels were calculated and are plotted in Exhibit 7-13. Both plots show a consistent decreasing trend in the average ratio levels. This indicates that there was a deterioration in the industry condition during the ten year test period. The retained earnings to asset ratio levels apparently changed from the 80s to the 90s.

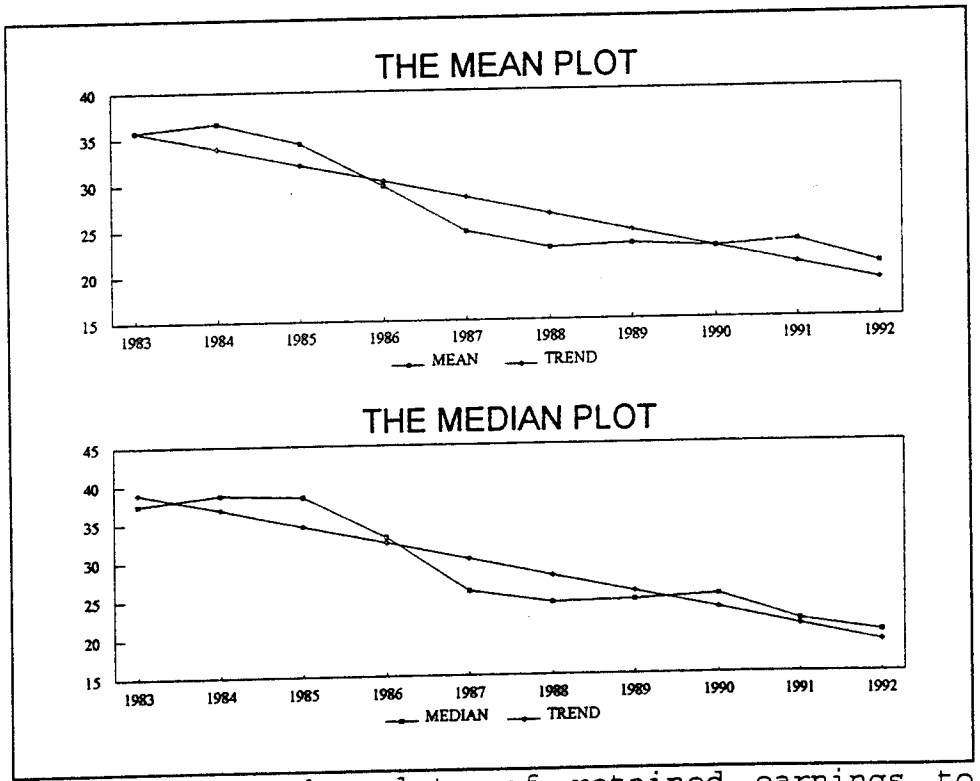

Exhibit 7-13 The plots of retained earnings to asset ratio

In order to analyze the significance of the change, the following statistical tests were conducted. The results are in Table 7-7, top panel.

The oneway ANOVA test was used to test the significance of difference in the yearly retained earnings to asset ratio values. The F-value is high and significant. Therefore, the null hypothesis of no change is readily rejected and it is concluded that there was a significant difference in the year-to-year ratio levels.

A t-test was conducted to see whether or not the change in the industry condition from the 80s to the 90s was significant. The t-value is 4.85, high to reject the null hypothesis of no difference. This provides strong evidence for the finding that there was a significant decrease in the retained earnings to asset ratio from the 80s to the 90s.

TESTS			**RETAINED EARNINGS TO ASSET RATIO**
Ratio Level	ANOVA	F^*	2.76
		p	0.004
	T Test	t^*	4.85
		p	0.000
Abs. First Diff.	ANOVA	F^*	1.51
		p	0.153
	T Test	t^*	0.05
		p	0.96

Table 7-7 Statistical test results

3. Uniformity Across Firms

The uniformity within the industry was measured by the dispersion in the retained earnings to asset ratio levels. The variance in the ratio is plotted in Exhibit 7-14. The variation plot shows an increasing dispersion throughout the ten year test period. This indicates decreasing uniformity across the firms within the industry.

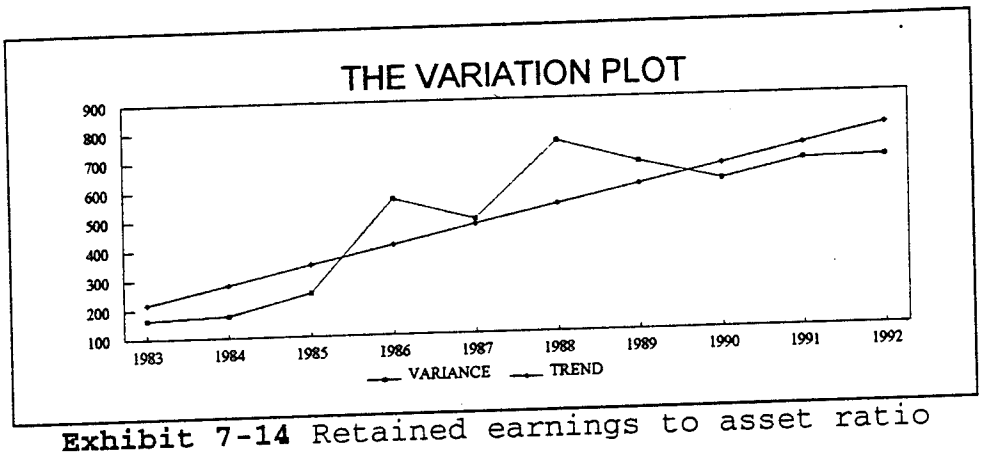

Exhibit 7-14 Retained earnings to asset ratio

4. Stability Over Time

Stability was examined by focusing on the absolute first annual differences of the retained earnings to asset ratio. The median of absolute differences of this ratio was calculated and is plotted in Exhibit 7-15. The plot shows no overall trend during the test period. Stability increased in 1989. However there is no systematic pattern.

The oneway ANOVA test was used to test the significance of year-to-year differences in the rate of change (instability) in the industry. The test results are in Table 7-7, bottom panel. The F-value is 1.51, moderate. The null hypothesis of no change can be rejected only at an 84% confidence level. This provides mild evidence for the finding that there was a significant difference in the rate of change in the retained earnings to asset ratio values during the test period.

A t-test was conducted to see whether or not industry stability changed significantly from the 1980s to the 1990s. The findings are displayed in the bottom panel of Table 7-7. The t-value is low and insignificant. The null hypothesis of no change can not be rejected. It is concluded that there is no significant difference in the stability of the retained earnings to asset ratio levels between the 80s and the 90s.

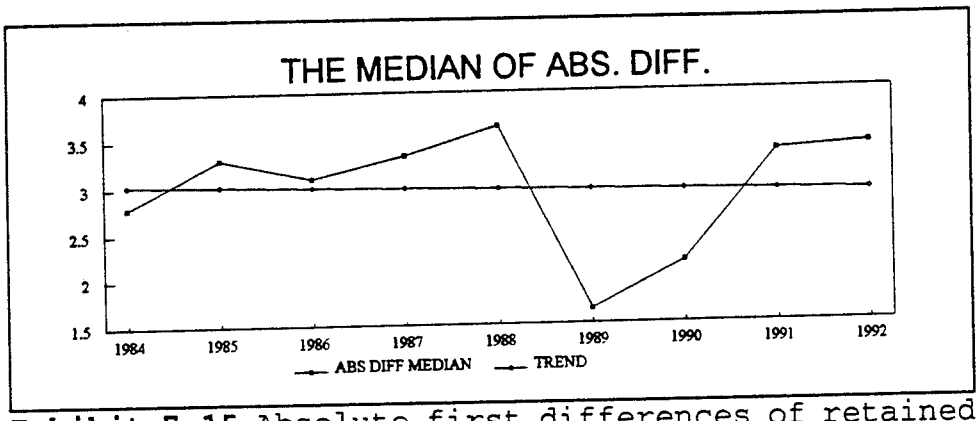

Exhibit 7-15 Absolute first differences of retained earnings to asset ratio

5. Time Series Pattern

Time series pattern of the retained earnings to asset ratio was examined by focusing on signed first annual differences. The median of the signed differences of the ratio values is plotted in Exhibit 7-16. The plot does not show any systematic pattern.

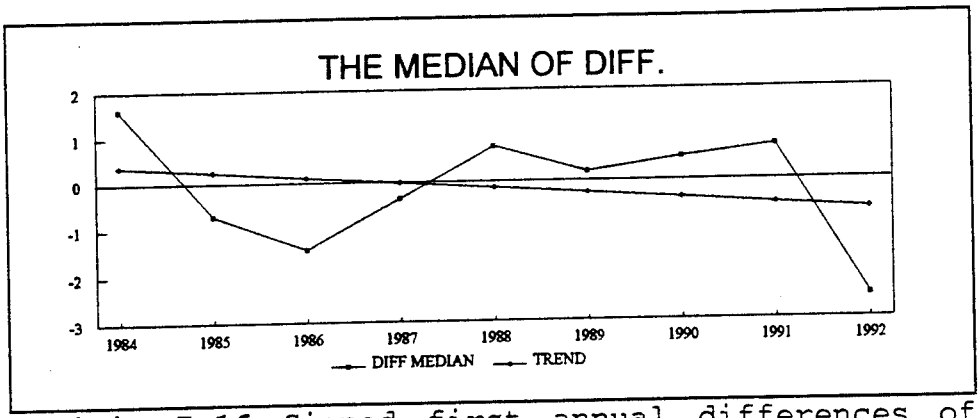

Exhibit 7-16 Signed first annual differences of retained earnings to asset ratio

Autocorrelation of first signed annual differences of the ratio levels were calculated and are displayed in Table 7-8. The autocorrelation values are not significant and consistent. This indicates that changes in one year are not related to changes the next, consistent with a "random walk" pattern.

84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
-.313	.090	-.320	-.254	-.290	.076	.137	-.057

Table 7-8 Autocorrelations of the first signed differences in the retained earnings to asset ratio

6. Summary

The retained earnings to asset ratio levels deteriorated significantly throughout the ten year test period. This indicates that the portion of funds provided by the undistributed earnings of the company decreased.

Dispersion in the ratio values increased during the test period. This indicates that uniformity across the firms within the industry deteriorated. There was also an apparent deterioration in stability of the ratio from the 80s to the 90s.

There was a significant difference in the rate of change in the retained earnings to asset ratio values at different years during the test period, but this difference was not evident between the 80s and the 90s. This indicates that there was no systematic pattern in the industry stability.

Changes in ratio values one year were not related to changes the next. This indicates that there was a "random walk" time series pattern in the retained earnings to asset ratio during the test period.

F. SUMMARY OF FINDINGS FOR LEVERAGE RATIOS

Capital structure of the industry firms changed significantly during the test period. All four leverage ratios showed consistent evidence of significant deterioration. Creditors' contributions to financing assets increased relative to the owners' contributions. This indicates that the business riskiness for industry firms increased from the 80s to the 90s.

Dispersion in the leverage ratios increased consistently during the test period. This indicates that uniformity across the firms within the industry deteriorated. Firms showed a variety of responses to changing economic conditions.

The industry experienced peak instability in 1986, and greatest stability in 1989. However there is no systematic pattern during the ten year test period.

There is no apparent time series pattern in the leverage ratios. All four ratios showed a general support for a "random walk" pattern. This indicates that changes in one year are not related to changes the next.

VIII. SUMMARY CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

The purpose of this study was to search for the existing financial ratio patterns in the defense industry. In recent years the defense industry in the United States has experienced significant turmoil. The thesis examined the manner in which economic and political changes were reflected in the financial ratio patterns of the defense industry firms. A summary of findings related to four research questions follows.

1. Industry Condition

The first primary research question was "what levels exist for the financial ratios". The condition of the defense industry was examined by focusing on the level (the values) of financial ratios between 1983 and 1992. The average value of ratios was measured by both the mean and median of ratio values for the sample firms for each year. Plots, ANOVA, and t-tests were used to examine differences in ratio levels over time.

a. Profitability

Profitability ratios showed an overall declining trend in the ratio levels during the ten year test period. This indicates that there was an obvious deterioration in the industry profitability levels within the ten year time frame. The industry tried to keep their profit margins within a reasonable levels. However, they could not keep their returns both on their assets and sales, as high as they had been.

This decrease in profitability ratios can be explained by either increasing cost and expenses, decreasing sales revenues, or a combination of both. But it is obvious that, the defense industry overall experienced declining profitability levels. This industry used to be known as a "cash cow", but conditions have changed.

b. Efficiency

Efficiency ratios did not show any consistent pattern of change. While asset turnover and turnover of working capital ratios were deteriorating, the fixed asset turnover ratio remained constant and the inventory turnover ratio improved. This inconsistency is not all that surprising. Firms could be efficient in the use of some resources and not in others. And different factors may affect the utilization of different classes of assets.

c. Liquidity

There was no change in either the current ratio or the quick ratio during the ten year test period. The cash ratio however, was an exception, showing a significant decrease. The cash ratio is the most conservative measure for liquidity. It can be concluded the overall industry condition in the liquidity did not change significantly between the years of 1983 and 1992.

d. Leverage

The capital structure of the defense industry firms changed significantly during the test period. All examined ratios showed consistent evidence of significant deterioration. The portion of debt increased in the capital structure relative to the stockholder's equity. This implies that creditors' contributions to financing assets increased relative to the owners' contributions and the business riskiness for the defense industry firms increased during the past decade.

2. Uniformity Across Firms

The second primary research question was "how much dispersion exists across the industry". Uniformity in specific aspects of the financial condition across the firms within the defense industry was examined by focusing on the dispersion in the level of financial ratios. The dispersion was measured by the variance of the ratio values for the

sample firms during each year. Plots were used to examine the dispersion in the level of financial ratios.

a. Profitability

The profitability ratios did not demonstrate any clear change in the uniformity across the defense industry. The were some years of relatively greater dispersion across the industry, but those years were different for each ratios.

b. Efficiency

There was no systematic pattern in uniformity of efficiency ratios within the defense industry during the ten year test period. There were some years of relatively greater dispersion across the industry. Between the years of 1986 and 1988 the defense industry experienced relatively higher uniformity in the efficiency ratios.

c. Liquidity

Uniformity across the firms within the defense industry in liquidity decreased during the ten year test period. Although the increase in dispersion was not readily apparent in the cash ratio, both the current and quick ratios showed a considerable increase in dispersion.

d. Leverage

The uniformity of leverage ratios of the defense industry firms deteriorated consistently during the ten year test period. The defense firms showed variety of response to changing environment.

3. Stability Over Time

The third primary research question was " have the level, the dispersion and variability of ratios changed?" Financial stability of the defense industry was explored by focusing on the magnitude of the year-to-year change (instability) in financial condition experienced by the firms. Change for the individual firms was measured by the absolute value of first annual differences in the ratio values. The average amount of change for the industry was summarized by both the mean and

the median of absolute first differences during each year of the test period. Plots, ANOVA, and t-tests were used to examine the stability of the defense industry over time.

a. Profitability

Generally the industry experienced the greater year-to-year changes (instability) in profitability during the 1980s. The industry profitability ratios except operating margin ratio were more stable during the early 90s. However the industry operating margin ratio showed decreasing stability over time.

b. Efficiency

The largest year-to-year changes (instability) in efficiency occurred between 1985 and 1986. Turnover ratios of the defense industry, except the inventory turnover ratio, seemed more stable in the early 90s relative to the early 80s. The inventory turnover ratio on the other hand, showed decreasing stability over time, especially after 1988.

c. Liquidity

The industry liquidity ratios showed consistent increasing stability over time. However, the increase in the industry stability was not always significant, particularly for the current ratio.

d. Leverage

There was no systematic pattern in the stability of the industry leverage ratios during the ten year test period. The industry experienced peak instability in 1986, and greatest stability in 1989.

4. Time Series Pattern

The fourth primary research question was "is there evidence of permanent change in the value of ratios or equilibrating forces are at work". Time series pattern of the financial ratios was examined by focusing on the relationships between successive year-to-year changes in the ratio values of the defense industry. Year-to-year changes was measured by

the signed first annual differences of the industry ratio values during the ten year test period. Plots and correlation between successive changes in a ratio value were used to examine the time series pattern of the ratio values.

a. Profitability

There was consistent evidence of "mean reverting" pattern in all examined profitability ratios during the ten year test period. This means that there was a tendency for the defense industry firms which experienced the largest increases (decreases) in profitability one year to follow with a decrease (increase) in profitability the next year.

b. Efficiency

There was a "random walk" pattern in the industry efficiency ratios during the test period. This indicates that changes in one year tended not to be related to changes the next.

c. Liquidity

There was no consistency in the time series pattern of industry liquidity ratios. While the cash ratio analysis provided some slight evidence of a "mean reverting" pattern, the current ratio and quick ratio appeared to be consistent with a "random walk." Overall all there is little evidence to suggest that year-to-year changes in liquidity ratios were related.

d. Leverage

There was no apparent time series pattern in the industry leverage ratios. Changes in one year were not related to changes the next. This is consistent with a "random walk" pattern.

B. CONCLUSIONS

The primary research question was "what patterns exist for financial ratios of firms in the defense industry". There were four parts to this question and the findings were just

summarized above. Overall the broad conclusion of the thesis are:

1. Condition

There was lower profitability, higher risk as reflected in leverage. This suggests worsening industry on both major dimensions of concern (risk and return.)

2. Uniformity

There was greater dispersion (less uniformity) across firms with respect to liquidity and leverage. This suggests firms are responding to the environmental changes with varying business and financial strategies.

3. Stability

Although not universal, there was a tendency for ratios to be more stable during the end of the test period (i.e., the early 1990s) when compared to the beginning (i.e., the mid 1980s), particularly when observing profitability, turnover and liquidity ratios. This suggests that the period of chaotic and unpredictable reaction to the environmental changes may have past.

4. Time series

Evidence is mixed but suggesting mean reverting pattern for profitability and random walk for turnover, liquidity, and leverage. This evidence is consistent with prior studies which have provided findings supporting both mean reverting and random walk characteristics.

C. RECOMMENDATIONS FOR FUTURE RESEARCH

The following questions might serve as a basis for further studies:

1. What patterns exist for financial ratios of the relatively small firms in the defense industry?

2. What patterns exist for financial ratios of the joint ventures in the defense industry? What are the advantages and disadvantages of mergers or further consolidation in the defense industry?

3. Can all the existing defense industry firms survive? What are the economic and political consequences of the shrinking defense industry to the United States?

4. What kind of new management tools are being implemented in order to deal with these changes?

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