ON THE ASSOCIATION BETWEEN FINANCIAL RATIOS AND SYSTEMATIC RISK UNDER ALTERNATIVE REPLACEMENT-COST MODELS

By

FOUAD M. EL-LEITHY

Bachelor Degree of
Financial and Commercial Sciences
Helwan University
Port-Said, Egypt
1963

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1978

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
May, 1982

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Thesis Approved:

Dale E. Armstrong
Thesis Adviser

Lawrence H. Hammer

Joseph M. Sadlow

Don Holbert

Norman N Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

Praise be to Allah and Peace be upon his messenger, Muhammed. I thank Allah for his help, guidance, and support during all of my study periods. My appreciation is expressed to the members of my dissertation committee, Dr. Dale Armstrong, Dr. Lawrence Hammer, Dr. Donald Holbert, and Dr. Joseph Jadlow for their sincere assistance throughout the preparation of this study. Sincere gratitude is extended to Dr. William Houston and Dr. Gary Meak.

My appreciation is expressed to my late parents for their encouragements. The support and patience of my sincere wife Hanna and my brother-in-law Hassan are unforgettable. Finally, my appreciation also extends to my brothers, Farouk and Yousri; my sisters, Wedad, Amal, and Eiman; and the many relatives and friends who had their part of sufferings and sacrifices during the course of my study.

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INTRODUCTION

The Usefulness of Financial Ratios

In theory and practice, financial ratios have been used by analysts to make intertemporal comparisons of a single firm and relative comparisons among firms. Academic researchers in accounting have long asserted that financial ratios are useful. Revsine (1973) stated that financial ratios, rather than absolute accounting numbers, are often utilized in such comparisons and analyses. Horrigan (1966) argued that financial ratios are superior to absolute accounting data for multivariate analysis purposes:

> Accounting data in absolute form are of quite limited utility because they usually provide only one piece of information, the size of a firm. That is to say, the various items in the financial statements of a typical sample of firms are usually highly correlated with each other. Therefore, accounting data must be transformed before they can be used in multivariate analysis. The usual types of transformation are trends, in the case of time series analyses, and financial ratios, in the case of cross-sectional analysis (p. 44).

The benefits derived from using financial ratios are usually enhanced by comparing the generated ratios of a specific firm(s) to some standard. Industry average ratios represent the most common standard. Generally, financial ratios have been utilized for various purposes such as (1) predicting business failure, (2) classifying firms on the basis of their financial characteristics, (3) determining credit standing, and (4) as independent variables in other univariate and multivariate models.

An Evaluation of the Effectiveness of Financial Ratios Under Alternative Accounting Models

Financial information based only on the traditional historical-cost model (hereafter HC), may not be comparable across firms. Different firms holding the same composition of assets may show different amounts on their financial statements depending on the prices that existed at the time of the acquisition of those assets. Another source of differences in the financial statements of different firms exists because different accounting methods are permitted under generally accepted accounting principles (GAAP) for the same item of expense or revenue. The use of different inventory valuation techniques, depreciation methods, and investment credit accounting methods provide only examples of the cause of differences. Furthermore, the HC model ignores completely the impact of price changes on the income determination and asset valuation of a firm. For these reasons, HC financial ratios have been criticized for their limited utility and lack of efficiency in fulfilling users' needs. However, it has been suggested by Revsine (1973) that certain replacement cost (hereafter RC) ratios may not suffer from these limitations.

The two alternatives to the HC accounting model that have been suggested for supplemental disclosure by the Financial Accounting Standards Board (FASB) in Statement of Financial Accounting Standards (SFAS #33) (1979) are:

> (1) Constant Dollar Model: In this model, financial statement elements are reported in dollars each of which has the same general purchasing power. This method of accounting is often described as accounting in units of general purchasing power.
>
> (2) Current Cost Model: where assets and expenses associated with the use or sale of assets are measured and reported at their current-cost or lower recoverable amounts at the balance sheet date or at the date of use or sale (p. 9).

Constant-dollar financial statements are presumably more objective than current value financial statements. On the other hand, the preponents of current value concepts claim that although it is less objective, it has a higher degree of relevance for managerial, lending and investment decisions.

At the present time, there is no uninamous agreement on a specific set of standards (i.e., a model) for measurement and reporting. One main reason for the resistance to change from the HC model to one of the alternative models appears to be that many accountants (and non-accountants) are not convinced that the proposed changes will produce more useful information. The SFAS #33 (1979, p. 5) states that: "Preparers and users of financial reports have not yet reached a consensus on the general, practical usefulness of constant-dollar information and current-cost information."

A possible explanation for the inability of the profession to resolve the issue of which accounting alternative to use relates to the unspecified linkage between user's information needs and the data provided to them. Thus, for a measurement model to gain a wide acceptance, its output must be viewed as relevant for the information needs of its intended audience.

Revsine (1973) suggested that before the usefulness of financial information can be determined, two crucial issues must be resolved.

First, the group(s) for whom the accounting information is to be provided must be specified. Second, the objective of the intended users must be identified. Since the users are heterogeneous and have different information needs, Revsine suggests that a universally relevant measurement concept is not likely to exist. In addition, he states that ". . . if one wishes to evaluate the relevance of an accounting measurement process . . . the analysis must be performed on a user category-by-category basis" (p. 19).

Accordingly, the usefulness of a measurement basis (like RC model) must be investigated sequentially for each major category of statement users.

The official response of the accounting authoritative organizations in the U.S.A. to the deficiencies of the HC model is cautious; hence, the change has been somewhat slow as compared to other countries. The reason might be that the U.S.A. has only faced the problem of a significant inflation rate only in the last decade. In order to alleviate the effect of changing prices on financial statements, the SEC issued ASR #190 on March 1976 which required certain registrants to disclose selective RC information with their 1976 filing if they meet a certain assets' size test. By issuing ASR #190, the SEC urged the profession to adopt the data expansion approach for measuring and reporting the price change information (Revsine, 1973).[1] As a result of this pressure from the SEC, the FASB (1969) issued SFAS #33, "Financial Reporting and Changing Prices."

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[1]The data expansion approach is based upon expanding the external reports to accommodate several measurement bases. This approach would allow the decision maker to determine for himself what data are relevant to his needs.

The Link Between Financial Statements' Ratios and The Market Measure of Risk

In modern portfolio theory, there is a positive linear relationship between the returns of a security and the market returns. The market measure of systematic risk (B_j) of a specific firm is the appropriate measure of riskiness of that security or of a portfolio of securities under a market equilibrium condition (Beaver et al., 1970; Gonedes, 1973; Short, 1977; Baran, 1980). An accounting model that improves the investor's assessment or prediction of the future level of the market risk measure would be useful in making investment decisions.

Rubinstein (1973) explained the relationship between the firm's operating and financial decisions and its systematic risk using the capital-asset pricing model:

$$E(R_{jt}) = E(R_{ft}) + B_j \ E(R_{mt} - R_{ft}) \qquad (1)$$

where:

- E = expectations operator
- R = rate of return measured by $\dfrac{(P_t + D_t - P_{t-1})}{P_{t-1}}$
- m = market
- j = stock
- t = time period
- f = risk-free
- B_j = systematic risk = $\dfrac{Cov\ (R_m\ ,\ R_j)}{Var\ R_m}$
- P_t = price of stock at period (t)
- D_t = dividend of stock at period (t)

He demonstrated that the expected rate of return on risky assets is a function of (a) risk-free rate, (b) expected rate of return to equity (for unlevered firms), and (c) expected returns to financial risk (for levered firms). Thus, equation (1) can be presented for portfolios falling on the market line as:

$$E(R_j) = E(R_f) + B_j^* \; E(R_m - R_f)\;(1 + B_j/S_j) \qquad (2)$$

where:

B_j^* = systematic risk of a firm with no debt
B_j = market value of debt
S_j = market value of equity
(The subscript t is deleted for convenience)

Assuming R_j^* = rate of return on equity (of an unlevered firm), and (R_j^*, R_m) is the correlation coefficient between R_j^* and R_m, Rubinstein (pp. 176, 177) showed that the risk-return ordered pairs of all securities fall along the market line:

$$\lambda^* = \frac{E\,(R_j^*) - R_f}{\rho\,(R_j^*, R_m)\,\sqrt{Var\ R_j^*}} \qquad (3)$$

Thus equation (1) can be presented as:

$$E\,(R_j) = R_f + \lambda^*\,(R_j^*, R_m)\,\sqrt{Var\ R_j^*}\quad (1+B_j/S_j) \qquad (4)$$

where: $(R_j^*, R_m)\sqrt{Var\ R_j^*}$ is defined as operating risk,

and (B_j/S_j) is the main determinant of financial risk.

Equation (4) provides theoretical evidence which indicates that: expected return for a stock equals the risk-free rate plus market (or nondiversifiable) risk. Furthermore, it indicates that market risk (B) equals two components: operating risk and financial risk.

Under the above equation, if a firm changes its operating and/or financial decisions and the market estimates that these actions and the new decisions will affect the firm's return and risk characteristics, (B) can also be expected to change. Therefore, (B) provides a link between the firm's behavior and the market valuation for the firm's stock (Breen and Lerner, 1973, p. 339).

Beaver et al. (1970) provided an evaluation (both theoretical and empirical)[2] of the usefulness of HC accounting risk measures as a surrogate for total variability of returns, generally, and systematic risk, especially. With respect to the dividend payout ratio (i.e., cash dividends/earnings available for common stockholders) they asserted that firms with low payout ratios are more risky. Regarding growth measure, assuming growth is defined in terms of earnings, excessive earnings streams are more uncertain (i.e., volatile) than normal earnings streams of the firm. Their theoretical analysis of leverage-ratio is based on the notion that as debt is introduced, the earnings stream of the common stockholders becomes more volatile (i.e., more risky). Finally, they advocated the prevailing idea that asset-size ratio is a good indicator of the degree of risk associated with expected returns; hence, larger firms are widely known as less risky than smaller firms. Alexander (1949) has found that the cross-section dispersion of the net income to net worth ratios does decrease as average firm size increases.

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[2]Refer to part III for their empirical results.

Revsine (1973) analyzed the utility of financial ratios by exploring not only their theoretical validity to assess risk but their usefulness as a basis for comparisons as well. He suggested that RC ratios which reflect a firm's liquidity-solvency positions (e.g., current-ratio and times-interest earned ratios) and those ratios that reflect a firm's profit generating potential (e.g., asset turnover, profit as a percentage of sales, and return on assets) are potentially more useful in risk assessment as compared to the same ratios under HC. His justification for the relevance of asset-turnover ratio computed under RC in assessing the risk of the firm is that this ratio is a function of the efficiency with which management used the assets in the past. Such efficiency in asset utilization should be a prime determinant of the level of future efficiency and hence of the level of future flows. In Revsine's opinion, the assets' turnover ratio computed using HC data is not dimensionally sound.[3] For the results to have a defensible meaning, the values in the numerator must relate to the same general time period as those in the denominator. In contrast, the assets' turnover computed using RC is dimensionally sound. The values for the assets employed and sales revenues are both stated in the same prices that prevailed over the reported operating period.

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[3]Dimensional soundness means that the units in which the numerators and the denominator are stated such that, after division, the quotient has unequivocal and meaningful interpretation.

Why Would We Expect the Correlation Between Financial Statements' Ratios and Market Measure of Risk to be Different for Different Accounting Alternatives?

Analytical and empirical research has shown that various accounting ratios are or ought to be good predictors of systematic risk.[4] Therefore, in order to evaluate the relevance to financial statement users of a specific accounting model, one could examine the utility of the ratios that are prepared from that model.

Since each accounting alternative determines income and valuates the assets on a different measurement basis, one would generally expect that each alternative would generate a specific set of financial ratios that are different from the other alternatives. To the extent that the market incorporates financial accounting ratios in its measure of systematic risk, the correlation between the market measure of risk and financial accounting ratios would differ under different accounting alternatives. That is, statistically speaking, one may measure the degree of association between the signals that each model produces (the ratios) and the systematic risk of the firm. The degree of association will indicate the relative importance of each data set to financial statements' users in the assessment of the security's systematic risk.

The development of a global accounting theory would require a comparison of the relevance of the financial accounting ratios, as

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[4]Refer to part III of this research.

computed under each possible accounting measurement basis, in satisfying the needs of a particular category of users such as equity investors. Since the correlation between financial accounting ratios under estimated constant-dollar model and ratios generated under the HC model have been studied (Short, 1977 and Black, 1979), it is the objective of the present study to fill in the remaining gap in the accounting literature through the empirical investigation of the correlation between financial accounting ratios and systematic risk under RC models.

The Problem

The primary purpose of the study is to evaluate (i.e., to: compute, compare, and analyze) the explanatory power of financial accounting ratios computed with RC data (as required by ASR #190) to that of the traditional financial accounting ratios computed with HC model in the assessment of the risk of an investment. The explanatory power of each accounting model under study was measured by the corrected (or adjusted) coefficient of determination ($\overline{R}^2$).

The study uses the multiple regression technique to evaluate and compare the relative usefulness of different accounting models. Systematic risk is used as a dependent variable while the financial ratios generated from HC and RC models serve as independent variables. Thus, two different RC models are created in addition to the traditional HC model. The first RC model (referred here as RC1) is based on the assumption that changes in holding gains or losses of assets during the period are treated as income. Thus, the main objective under RC1 would be to maintain capital in its financial concept or the number of dollars invested at the beginning of the period. The second RC model (referred here as RC2) assumes the physical capital maintenance concept, i.e., changes in assets' amounts during the year are not considered as a distributable income, rather they are accounted for in the firm's equity section. Thus, holding gains or losses are treated as a capital adjustment under RC2.

The relative usefulness of the three accounting models (HC, RC1, and RC2) for explaining the systematic risk (B) was evaluated for each firm in the sample. Systematic risk (Beta) for firms was computed using CRSP annual tapes and applying Scholes and Williams (1977) technique which compensates for bias in estimating alphas and betas due to non-trading days when using daily return data. Meanwhile, expanded COMPUSTAT file, annual reports, and form 10K's were used simultaneously to generate the three sets of independent variables for each firm. Factor analysis (F.A.) multivariate technique was used to serve two main purposes. First, it was used to transform the interdependent ratios into independent factor scores that could be used as explanatory variables and hence fulfill the multiple regression assumption of independence of explanatory variables. Second, the factor analysis technique was used as a data reduction device.

Systematic risk was regressed firstly on HC reduced factor scores, then the process was replicated using RC1 factor scores, and finally on RC2 factor scores. The model with the highest adjusted coefficient of determination ($\overline{R}^2$) and lowest standard error (s.e.) was considered as the one that had the highest explanatory power.

Since investor's evaluation of the degree of the explanatory power of the alternative accounting models entails some sort of judgement analysis (JAN.), most of the empirical research in this field (e.g., Houston and Giplin [1971]) presumes the difference to be significant if the actual difference in the adjusted coefficient of determination is (±.05) or more; therefore, this study utilizes this *a priori* significance criterion to evaluate the significance of the differences of explanatory power.

The Research Questions

The specific research questions and their significance are as follows:

Research Question I

> Does the utilization of RC data cause a significant change in the explanatory power of the traditional HC data of systematic risk of the firms?[5]

The answer to this question might provide a valuable evidence to long term equity investors generally and to those charged with analyzing financial statements specifically. A positive answer would provide a clue and support the assumption of the validity and superiority of RC information in assessing the value of a security. On the other hand, a negative answer (i.e., no significant change in the explanatory power) might imply one of the following:

1. The capital market agents do not perceive new information in RC data.
2. There may be a larger time lag between the disclosure of RC information and its impact on systematic risk which the model used in this study did not utilize.

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[5]Explanatory power of any model will be measured by the adjusted coefficient of determination ($\overline{R}^2$) and its standard error (s.e.).

3. RC information may still have an impact in the long run on betas (e.g., see the research done on the information content of SEC Line of Business reporting by Horwitz and Kolodny [1977] and by Collins and Simonds [1979]).

Research Question II

The second question is whether changes in the measurement characteristics of the individual ratios due to the RC adjustment process exist. For example, under HC model, debt/net worth ratio might be a measure of financing policy; however, under RC1 model where changes in unrealized holding gains are included in income, the same ratio might be a measure of profitability rather than financial policy (that is, the ratio might be more highly correlated with the profitability factor than with financing factor).

Revsine (1973, p. 186) concludes his book with the following sentence: "A complete analysis of the reputed advantage of RC ratios would require an empirical determination of the specific ratios that are useful in risk assessment."

In this study, the investigation of the impact of RC adjustments on the measurement characteristics of the financial ratios was done by comparing the factor structure of the HC ratios with the factor structure of the RC ratios. Schonemann and Carroll's (1970) effective technique was used to rotate each of the RC factor structure until it was similar to the HC factor structure. At this point, the rotated problem space matrix (either of the RC models) was subtracted from the target space matrix (HC model) to produce the residual matrix. Analyzing the generated residual matrix helped specifying the ratios that might cause the significant change in the explanatory power of HC model.[6]

Thus, research question II reduces to:

> Is the factor structure of HC model significantly different than the factor structure of each of the RC models?

Specifically, the empirical variant of this question is as follows:

> What are the specific financial ratios under each of the RC models that might cause the significant change in the explanatory power of the HC model?

If the results of the research questions (1) and (2) are positive, they indicate a change in the explanatory power of the traditional HC data of systematic risk of the firms. Specifically, if the association between systematic risk of firms and the financial ratios under HC model is higher than under the other two RC models, this implies that the market uses and prefers HC data rather than any of the other two RC models. On the other hand, if the association under either one of the RC models and its financial ratios is higher than that of the HC model and the other RC model, this indicates that the market prefers that RC model. Finally, if the results are ambiguous, it may indicate that the market uses and integrates the financial ratios from all possible accounting models and other sources of information.

Research Question III

> Which capital maintenance concept (financial vs. physical) will be more highly correlated with systematic risk estimations?

The present study utilizes both the historical and replacements-

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[6]Refer to Appendix B for a detailed explanation of the mathematical derivation of this technique.

cost (ASR 190) as the net asset valuation rules. Meanwhile, the financial and physical capital concepts are applied simultaneously along with the above two assets attributes. Specifically, using Shewyder's (1969) analysis the models presented in Table I are investigated.

TABLE I

ACCOUNTING MODELS INVESTIGATED

Model	Type	Net Asset Valuation Rule	Capital Maintenance Concept
HC	Historical Model	Unadjusted historical cost	Financial, i.e., monetary units to be kept intact
RC1	Replacement-cost, Holding gains income	Replacement-cost (ASR 190)	Financial, i.e., monetary units to be kept intact
RC2	Replacement-cost, Holding gains capital Adjustment	Replacement-cost (ASR 190)	Physical, i.e., physical units to be kept intact

A positive result for research questions 1 and 2 would determine which capital maintenance concept has a higher explanatory power for systematic risk of firms.

Organization of the Dissertation

The next chapter provides a literature review related to the association area. Data source, concept and measurement of risk, selection of financial ratios, Factor analysis experiment design are included in Chapter III as components of research design. In addition, Chapter III also includes: the research hypotheses and the criteria used to evaluate the degree of association. The fourth chapter presents the research results and their interpretations. Research conclusions, implications, limitations of these conclusions, and suggestions for further studies are presented in the fifth and final chapter.

CHAPTER II

HISTORICAL PERSPECTIVE ON RISK ASSOCIATION STUDIES

Previous empirical efforts to study the association between accounting measures of risk (as represented by the accounting ratios) and the market risk (i.e., beta generated from the market model) have approached the problem from different perspectives. The first section in this chapter will review the studies which are based on HC accounting models, while the second will deal with those studies that emphasize the use of price-changes models. The final section will provide an over-all summary and evaluation of previous research, and point out how the present study will attempt to overcome some of their limitations.

Association Studies Based on HC Model

The quantity of research in the association area has significantly increased in the last decade. Some examples, of HC based association studies include: Beaver, Kettler, and Scholes (1970), Pettit and Westerfield (1972), Gonedes (1973), Breen and Lerner (1973), O'Conner (1973), Lev and Kunitzky (1974), Bildersee (1975), Beaver and Manegold (1975), and Thompson (1976).

Beaver, Kettler, and Scholes (1970), examined the degree of contemporaneous association between certain accounting ratios and the beta coefficient of the market model. Specifically, their investigation was based on the following accounting risk measures (i.e., instrumental variables):

1. Dividend pay out.
2. Growth of assets.
3. Leverage.
4. Liquidity.
5. Asset Size.
6. Variability in earnings, and
7. Covariability in earnings.[1]

Beaver et al. (1970) conducted two tests. First, cross-sectional correlations, at the individual security level and at the portfolio level, were computed between market beta and each of the seven variables. They found that the correlations were significant for dividend pay out, leverage, earnings variability and the accounting beta. As expected, the correlations were higher for portfolios. Second, Beaver et al. (1970), also examined the ability of the individual decision maker to use accounting risk measures in period one (1947-56) to forecast the market beta in period two (1957-1965). They found that the multicolinearity between the three accounting variables (dividend payout, growth, and earnings variability) was very low. These three variables were included in their final regression model and the others were deleted due to their high degree of multicolinearity.

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[1]The earnings variable chosen was net income available for common stock outstanding (i.e., the earning-price ratio). The accounting beta can be derived in a similar manner to market beta. That is, from a time series regression with the firm's earnings-price ratio as dependent variable and some economy-wide average of E/P as independent variable.

The authors concluded that:

> The evidence indicated that accounting risk measures can be used to select and to rank portfolios such that the ranking has a high degree of correlation with ranking the same portfolios according to the market risk measure (p. 670).

This finding is consistent with the joint hypothesis that accounting data do reflect the underlying events that determine differential riskiness among securities and that such events are also reflected in the market prices of securities.

Pettit and Westerfield (1972) investigated primarily the hypothesis that the slope coefficient of the market model (market beta) is a function of a cash flow covariance and a capitalization rate (that is, an earnings-price ratio) covariance. Their conclusion also tends to confirm the existance of a significant association between the market model slope coefficient and the corresponding cash flow and capitalization rate covariance terms. This significant degree of association has been highly improved when firms were grouped in portfolios.

Furthermore, as part of their study, Pettit and Westerfield also examined the impact of the following accounting variables on market beta:

1. Payout ratio.
2. Debt-equity ratio.
3. Firm size.
4. Current ratio.
5. Growth in earnings.

The relationships between debt-equity and current ratio with market beta were found to be insignificant but when all the accounting variables with the exception of the current ratio were included in a regression model, the coefficient of determination was found to be fairly high (up to .84 for 25 firm portfolios).

Gonedes (1973) investigated the correlation between the information impounded in market prices and that impounded in accounting numbers. The theoretical basis of his study is that if the correlation between the information reflected in accounting numbers and the information impounded in market prices is "low" then the valuation models that use these numbers may have little descriptive validity and do not capture much of the information impounded in market prices. The main question that Gonedes was addressing was: whether or not accounting income numbers convey information about the systematic risk of an asset. Gonedes considered that estimated coefficient of determination, $\overline{R}^2$, from the market model provides an estimate of firms' systematic risk (or "systematic variability"). Furthermore, he also considered the estimated coefficients of determination from the accounting income numbers models as estimates of the systematic variability associated with firms' overall operations. Gonedes performed a test of the correlation between market-based and accounting-based estimates of systematic variability using the estimates of systematic variability of the accounting-income numbers model and the estimates of systematic variability from the market model.

Gonedes found (in general) a statistically significant relationship between market-based and accounting-based estimates of systematic risk when the accounting-based estimates are derived from the first differences in income numbers or scaled first differences. A possible explanation of this significant relationship when the first difference of accounting ratio was computed is that the first difference can eliminate the effect of the trend over the study period and hence has a better ability to reveal the specific stochastic process underlying the observations. Gonedes concluded that ". . . all estimated correlation coefficients are less than $\overline{R}^2$ = .45. This suggests that much of the information in security prices is not reflected in accounting income numbers" (p. 436).

Gonedes' final conclusion is consistent with the assumption that capital market agents are provided with others competing sources of information in addition to the accounting numbers.

Breen and Lerner's (1973) study is an attempt to measure the relationship between different corporate financial accounting variables and market beta. They have chosen the following independent variables arbitrarily to describe the changes in a firm's value of beta:

1. Debt-equity ratio.
2. Debt-equity ratio squared.
3. Growth in earnings.
4. Stability of the growth in earnings.
5. Size of firm (number of outstanding shares X market price on the terminal date of the period).
6. Dividend payout ratio (dividends paid/reported earnings).
7. Number of shares traded during the reported period.

Their research study indicated that the regression coefficients were significant for earnings stability, size of the firm, dividend payout, and numbers of shares traded, but the coefficient of determination for the model as a whole was rather low.

O'Connor's (1973) test represents the only exception to the existing notion that financial ratios serve as explanatory variables in association or predictive ability tests. O'Conner investigated the association between financial ratios, arbitrarily selected, averaged over a period of time and the rate of return on common stocks averaged over a subsequent period of equal length. The analysis used simple average ratios and exponentially weighted average ratios. In addition, the analysis was repeated after adjusting the average rate of return for the market and industry effects. The results of his univariate and multivariate tests were negative, the explanatory variables (ratios) did not show much ability to explain the variability in the explained variable (rate of return) under all the four sets of models.

O'Conner's conclusions was that: "In general, neither the simple average ratio models nor the exponentially weighted average ratio models showed statistically significant ability to predict future rate of return rankings" (p. 351).

Furthermore, O'Connor concluded:

> The evidence provided by the analysis--casts strong doubt upon the usefulness of financial ratios . . . That is, the variability of the usefulness assertation that seems implicit in textbook discussions of ratios, in disscussions of financial ratio values in the investment literature, and in the wide publications of ratios values by investment analysis firms is questionable, given the particular ratio models of the study [emphasis added] (p. 351).

Nevertheless, O'Conner's strong conclusions have not gone uncriticized. In Abdel-Khalik's (1974) opinion, O'Conner's research design and the testing procedures are not quite appropriate for drawing a definitive statement about the usefulness of financial ratios. Specifically, Abdel-Khalik noted in reviewing O'Conner's article that:

> It is my belief that the regression equation and the parameters estimated were not valid for predictive purposes for three primary reasons: (1) the choice of the explanatory ratios was peculiar, (2) the issue of the ratios' multicollinearity, and (3) the use of unadjusted R^2 as a measure of the explanatory power (p. 547).

Lev and Kunitzky (1974) expanded study of the basic relationship by including measures of smoothness (mean absolute percentage deviation of the actual changes in the variable from the trend) for variables such as sales, earnings and dividends. The dividend payout ratio, leverage and firm size were found to be associated with systematic risk as well as certain smoothness measures. The study also examined this relationship based on industry classifications and found that the correlations between accounting variables and market beta were significantly altered by industry classification.

Bildersee (1975) found similar results when compared with the other studies but reaches a different conclusion based on those results. He developed three samples of firms based on industry classification: (1) manufacturing and retailing; (2) firms in 1 plus utilities; (3) firms in 1 and 2 plus transportation and performed a stepwise regression. The results show that the relevant variables in each model appear to be a function of the sample. Bildersee also notes a fairly low coefficient of determination and concludes that: "It appears that accounting variables alone and in their present form may not have a strong association with beta in the case of common stocks" (p. 90).

Work by Beaver and Manegold (1975) continued the examination of the relationship between accounting beta and market risk. The study examined a technique proposed by Vasichek (1973) to improve the measurement of beta. The procedure involves a Bayesian estimate of beta by adjusting the observed betas toward the mean of the cross-sectional distribution. Hence high betas are reduced and low betas are increased. The Bayesian procedure has a considerable impact on accounting betas (which will not be used in the present study) but has only a minimal impact on market beta. For their sample, the mean of beta is unchanged while its standard deviation is reduced by .04.

Thompson (1976) examined the relationship between forty-three variables and market beta with correlation and regression analysis. A large number of variables (twenty) were found to have significant correlation coefficients. The covariant forms of certain variables appeared to explain differences in beta better than the analogous mean or variance forms.

Association Studies Based on Price Changes Models

Association research which is based on price-changes accounting models are few as compared to research based on the traditional HC model. The justification for this scarcity might be that the inflation rate in the U.S.A. did not increase significantly before the last decade. In addition, the accounting authoritative bodies only started mandating the price changes in 1976 by issuing ASR #190 by the SEC. Furthermore, all the existing studies which tackled the price-changes models are based on the general price-level model, only. Short (1977), Devon and Kolodny (1978), Hillison (1979), and Baran, Lakonishak, and Ofer (1980) are examples of these studies.

Short (1977) investigated the explanatory power of the estimated price-level and historical data. Two regression models were developed: the first model regressed the estimated market beta on selected historical cost accounting ratios, while the second model regressed the same estimated betas on estimated price-level adjusted accounting ratios. Short's results showed a 34 percent increase in the explanatory power of the model based on price-level adjusted data. Short's research is of particular importance here because the present study is an extension of his work.

Devon and Kolodny (1978) investigated the value of price-level adjusted data to users of financial statements. Based on SFAS Exposure Draft (1974) and using the association between earnings (adjusted and unadjusted) and security prices for the period 1964 to 1973, they concluded that changes in price level earnings are more strongly related to the market performance than are historical-dollar earnings.

Baran (1976) investigated the relationship between security price changes and alternative earnings numbers with primary emphasis upon the estimated price-level earnings figures. He concluded that historical cost earnings' changes were consistently found to be more closely associated with security returns' variations than were their restated counterpart.

Furthermore, in a recent study by Baran et al. (1980), they investigated the extent to which price-level data contain information not included in the historical-cost data. Their measure of information was the degree of association between the market systematic risk and the accounting beta. Baran et al. concluded that price level restated data contain information which is not included in the financial reports currently provided. The association between market beta and GPL adjusted betas was significantly higher than those observed between market and historical cost betas.

Hillison (1979) examined the association between unexpected general-purchasing-power-adjusted earnings per share (GPPA eps) and the abnormal market returns' movement and compared it with the traditional unexpected earnings per share association. Although the data for his study were from 1970 through 1974, where the decrease in the purchasing power of a dollar was the most significant, he concluded that using the first difference models reveals no significant difference between traditional and GPPA eps; however, analysis of the second difference models indicates that the traditional model significantly outperformed the GPPA model. The test supports the proposition that GPPA data are not incorporated in market agents' expectation models.

Expected Contribution

The above studies have principally utilized the historical accounting data (either in its traditional form or adjusted for the impact of changes in purchasing power) and have found that a relationship does exist between accounting numbers and market risk. The use of the HC model generates measurement discrepancies not only because the firms use different accounting methods for the treatment of the same item (especially for inventory valuation techniques and computation methods for depreciation) but also because it generates an income figure which is regarded as a poor estimator of the firm's expected future cash generating capabilities (Revsine, 1973). In addition, in all of the above studies (with the exceptions of Short's study) the selection of the financial ratios was neither based on existing theoretical grounds nor any objective criteria. Furthermore, the researchers used their own estimates of general price-level information due to the nonavailability of actual data. Finally, the studies provide no general or specific information about the overall structural changes of the data due to the implementation of their own assumed models. None of the above researches has utilized or investigated the validity of RC models in the association area.

This study can be regarded as an extension of Short's (1977) work. The same methodology (Multiple regression and Factor analysis) is used, and the same general accounting model (price changes) is investigated. The two studies share some common features: market beta is the dependent variable, financial ratios are independent variables and have been reduced and transformed using the Factor analysis, and selection of ratios is based on an objective criteria. On the other hand, both studies have some basic differences. Short's model of investigation is the estimated general price-level model, while the present study is based on actual replacement-cost models as required by ASR #190. In addition, the dependent variables (market beta) were computed by Short on a monthly basis for 48 and 84 months while the independent variables (financial ratios) were computed for only one year (1972). Consequently, the sampling error for such a small number of observations of the independent variables was very large. The use of a short time period had an impact on his analysis of the results. Short's conclusion was:

> The coefficient of determination for regression models with market risk and accounting measures were less than .60. This suggests that factors not measured by accounting ratios influence risk, or that the variables are measured with error (p. 107).

The present study will estimate the parameters in the market model (alpha and beta) using an unbiased and a consistent econometric technique (that is, the instrumental variables) developed by Scholes and Williams (1977) for daily return data. This method compensates for biases due to non-trading of daily returns. Furthermore, it is the unique feature of this study to investigate the possible impact of the timing factor of RC information on the market beta. Specifically, although the independent variables (financial ratios) is based only on 1977 reporting, this study attempts to trace the possible impact of the release of RC information on the dependent variable (market beta) for the sample firms utilizing three main time-period alternatives. Therefore, Scholes and Williams market betas have been computed based on the following three time-periods:

- -Period I from 11/1/1977 to 12/29/1978 (14 months)
- -Period II from 1/3/1978 to 12/29/1978 (12 months)
- -Period III from 3/1/1978 to 12/29/1978 (10 months)

Finally, the significant variables (ratios) under the RC models that might alter the risk assessment will be delineated by using a specific structural changes' model developed by Schönemann and Carroll (1970).

Summary

Previous research studies in the association area used market beta as dependent variables and arbitrary financial ratios as independent variables. However, the majority of their results indicated a relatively small portion of the variation in beta. In this research effort, the main objective is clear:

> What is the impact of actual RC models on the explanatory power of the market beta?

CHAPTER III

RESEARCH DESIGN

The purpose of this chapter is to indicate the data source, explain the nature and the selection of the dependent and independent variables, state the research hypotheses and to provide a detailed description of the research methodology.[1]

Variables Identification

The main question addressed in this study is whether or not the association between accounting data and the systematic risk measure is different for HC and RC models. Association is measured by the corrected coefficient of determination of the regression analysis for each of the three basic models and takes the following form:

$$Y = a + b_{h1} X_{h1} + b_{h2} X_{h2} + \ldots + b_{hn} X_{hn}. \qquad (1)$$

where: Y = Market measurement of systematic risk (dependent variable)

X_{hi} = HC accounting ratio for $i=1,\ldots,n$.

and:

$$Y = c + b_{r1} X_{r1} + b_{r2} X_{r2} + \ldots + b_{rn} X_{rn} \qquad (2)$$

where: X_{ri} = RC accounting ratio for $i=1,..,n$. When holding gains or losses are treated as income.

and:

$$Y = g + b_{p1} X_{p1} + b_{p2} X_{p2} + \ldots + b_{pn} X_{pn} \qquad (3)$$

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[1]A detailed description of the RC estimation and adjustments procedures adopted in this research is provided in Appendix A.

where: X_{pi} = RC accounting ratio for i=1,...,n. When holding gains or losses are treated as capital adjustment.

This study, like most related ones, focused on the long-run equity investor (i.e., the investor in common-stock). Theoretically, Revsine (1973) has selected this category of users in his evaluation of the usefulness of replacement cost information because they rely more heavily on financial reports than other users; they are assumed to be the primary users of these reports; and their needs are directed toward predictive data.

Sample Selection and Data Source

This research investigated the association beween financial ratios and systematic risk under three types of measurement bases: HC, current RC where the holding gains are treated as income (named here RC1), and current RC where the holding gains are treated as an adjustment to the capital account (named here RC2).

The primary data source that was utilized in the development of the HC accounting ratios is the COMPUSTAT primary annual tapes for the selected firms. The annual reports and 10K forms for the same firms were used in the computation of the ratios under the other two models of RC. Furthermore, CRSP tapes were used to generate the market betas during the study period (that is 1977). Fifty firms have been randomly selected from the COMPUSTAT tape. The major criteria for selection was that each firm chosen was subject to the ASR 190 assets' size test because only those firms were required to disclose the RC data. Furthermore, the following selection criteria were used for omitting firms from the analysis:

1. Firms were omitted if they were not listed on both the COMPUSTAT and CRSP annual tapes simultaneously for the period of the study. The reason for imposing this restriction is that if a firm is listed on the COMPUSTAT and not listed on CRSP tapes, it would be possible to generate its financial ratios but not possible to compute its market risk (B), and vice versa.
2. Firms not having a December 31 fiscal year-end were omitted. Since systematic risk for a specific firm reflects an estimate of the covariance between its security's return and the total market return, selecting firms that have a uniform year-end date resulted in a return figure (or risk figure) that is affected by the same prevailing general economic conditions.
3. Firms were omitted if stock prices or historical financial statements were missing for the study period.
4. Firms that provided ambiguous RC information were omitted.

Financial ratios for each selected firm were computed for 1977 reporting year. For each firm, the computation of 1977 RC financial ratios under RC1 and RC2 models required a careful analyis and use of the 1976 financial information in addition to the 1977 data. The main reason for selecting these two specific periods is partially explained by Ro (1981):

> Conceptually, unrealized holding gains for a period are measured by a change in cumulative unrealized holding gains during the period. However, since ASR 190 accounting data are not available for the 1975 fiscal year, it is practically impossible to compute a change in unrealized holding gains for 1976 (p. 73).

The Concept and Measurement of Market Risk (B)

Definition of Market Risk

There appears to be general agreement in the finance literature that the risk of holding an investment is associated with the variability of returns. In modern capital market theory, returns of securities are linearly related to the market returns in the following form:

$$\tilde{R}_{it} = \underbrace{a_i}_{\text{certain}} + \underbrace{\overbrace{B_i \tilde{R}_{mt}}^{\substack{\text{common}\\\text{systematic}}} + \overbrace{\tilde{e}_{it}}^{\substack{\text{individualistic}\\\text{unsystematic}}}}_{\text{uncertain}}$$

where: $\tilde{R}_{it}$ = Return on security i at time t

$\tilde{R}_{mt}$ = Return on market portfolio at time t

a_i = Risk-free return on security i

B_i = Systematic risk on security i

$\tilde{e}_{it}$ = The random component of the security i's return at time i

The above market model indicates that a security's returns are influenced by two factors: $B_i \tilde{R}_{mt}$ which is called the systematic risk, or nondiversifiable risk, and $(\tilde{e}_{it})$ which is called unsystematic risk, or diversifiable risk. Systematic risk represents that part of the variability of the firm's rate of return that is attributable to common movement in the market as a whole. It is defined statistically as the covariance of a security's return with the return from the market portfolio, standardized by the variance of returns from market portfolio. Unsystematic risk $(\tilde{e}_{it})$ represents that part of the variability of the firm's rate of return that is not explained by general market movements and is therefore attributable to the characteristics of the issuing firm.

According to the modern portfolio theory, investors can reduce unsystematic risk by holding well diversified portfolios. Therefore, the expected return on a security is not related to the total risk but to the systematic risk (B) only. Thus, from a portfolio, rather than an individual security point of view, the relevant risk measure of a stock is its sensitivity or responsiveness (B_i) to market wide or general, economic fluctuations ($\tilde{R}_{mt}$).

Calculation of Market Risk

Short (1977) draws attention to the importance of distinguishing between the concept of risk and the measurement of the risk. The former is an instant measure while the later is a period measurement. Short states that: "One can think of a firm having certain risk characteristics at a given instant in time but the measurement of risk (market beta) is a period measurement" (p. 34).

In addition, Short presents an example familiar to accountants:

> One can think of a firm with certain profitability characteristics and net income might be used as a measurement of profitability. As accountants know, one cannot speak of net income 'at a specific time.' Net income is a measurement for a period of time. Further, if one attempts to measure net income for an extremely short-time, the measurement errors would be so great as to make the result virtually meaningless. The same may be true of market beta (p. 34).

The calculation of beta in this study required the determination of two crucial points:

1. Which time period calculation basis (daily, weekly, or monthly returns) should be used?
2. What length of the time should be used to calculate beta?

Previous research (Levy, 1971; and Blume, 1971) provides evidence that supports the existence of measurement error in the calculation of beta when using the daily returns; however, this error is alleviated when weekly or monthly data is used. Scholes and Williams (1977) (hereafter S-W) have shown that due to non-trading, ordinary least square estimators in the market equation are biased when applied to daily return data. In particular, alphas are upwardly biased and betas are downwardly biased for firms which are either actively or inactively traded. The reverse is true for firms with more average trading frequencies. S-W present alternative estimation procedures which compensate for these biases and detect the unbiased, and consistent estimators as follows:

$$\overset{*}{\alpha}_i = \frac{1}{T-2} \sum_{t=2}^{T-1} r^s_{it} - \overset{*}{B}_i \frac{1}{T-2} \sum_{t=2}^{T-1} r^s_{mt} ,$$

$$\overset{*}{B}_i = (\overset{-}{B}_i + B_i + \overset{+}{B}_i) \;/\; (1 + 2\hat{\rho}_m),$$

where $\overset{-}{B}_i$, B_i, and $\overset{+}{B}_i$ are the ordinary least squares estimates obtained by regressing r_{it} on $r_{m,t-1}$, and $r_{m,t+1}$, respectively; and $\hat{\rho}_m$ is the autocorrelation coefficient for the market index.

Therefore, in this study unbiased beta was calculated on daily return data using the above S-W procedure. Utilizing the least square multiple regression in the above market model, the returns of each firm were regressed on the market index to generate the betas. The generated beta for each firm was later used as the dependent variable in the final analysis.

Furthermore, the present study attempts to answer an unresolved and interesting question in the association between accounting data and market prices. The general form of the question is:

> What is the time-structure of the relationship (i.e., lead, contemporaneous, lag) between accounting data and market prices?

Specifically, the question is to determine the impact of the chosen time-length period for beta calculation on the degree of association. Empirical evidence indicates that the market is efficient in the semi-strong form. In the semi-strong form of efficient market, market prices (and hence betas) of firms fully reflect all publically available information. Consequently, the actual dates of information disclosures (both information leaks by management and the issuance of formal financial statements) are critical in the determining the degree of association between financial information and the market measure of risk. Since the present study used the financial ratios of 1977 as a basis for calculating the explanatory variables in the regression equations, there are at least three different reasonable time periods for calculating the explained variable (B).

Alternative I. The period base selected is the fourteen months from November, 1977, to December, 1978. The justification for this base-period is that it starts from November, 1977, which is about the time that 1977 financial information for most of the sample firms chosen (i.e. which have a December 31 fiscal year) begins to leak out to the public through management reports. This financial data might have been used by investors and hence might have an impact on the betas. In addition, this fourteen-month period has the advantage of including the periods included in the other two alternatives.

Alternative II. The period base under this approach is the twelve months beginning in January and ending in December, 1978. In this case, a complete lag period of one year was arbitrarily chosen.

Alternative III. This approach might be called the pure alternative, where the period chosen is the ten months beginning in March and ending in December, 1978. The period of computing the betas starts from March, 1978, when most of the sample firms file their 1977 financial data with the SEC and ends in December, 1978. The reason for selecting December, 1978, as the ending period for the three above alternatives is to avoid the possible impact of the 1978 reporting of financial data.

Since there is no theoretical or empirical definitive answer to the time-structure of the relationship between systematic risk and the financial ratios, this study attempted to evaluate the overall possible impact of the above three time-periods on the explanatory power (as measured by the adjusted coefficient of determination) utilizing the three accounting models of the study (HC, RC1, and RC2).

A final issue is the selection of an index to measure the general market return ($\tilde{R}_m$). Empirical evidence (Lori and Hamilton, 1973; Fama, Fisher, Jensen and Roll, 1969; Sharpe and Cooper, 1972) suggest that selection of a specific index will not have a substantial impact on research results. Therefore, the CRSP equally weighted market index was used in this study.

The Selection of the Financial Ratios

In order to test the association between any two groups of variables, it is first necessary to establish an explanatory relationship between the independent variables and a dependent variable of interest. For this study, financial accounting ratios are identified as independent variables and the stock's systematic risk as the dependent variable.

Different possible approaches could be used in selecting the independent variables such as: (1) selection based on a theoretical relationship between accounting variables and market risk; (2) inclusion of all accounting ratios; (3) stepwise regression; and (4) data reduction with factor analysis.

There is no specific theory that depicts the relationship between the various accounting ratios and systematic risk. Even if one hypothesizes that market risk is a function of business risk and financial risk (Rubinstein, 1973; Abdel-Khalik and McKeown, 1978), there may exist a ratio, other than the specified ones, that shows a higher relationship with market measure of risk.

If one includes <u>all</u> accounting ratios, it would permit a test of total explanatory power of each set of accounting data; however, the high degree of multicollinearity among the ratios would make it difficult to evaluate the strength of the regression coefficients and thus the explanatory power of individual ratios. Stepwise regression suffers from the same deficiencies as including all variables. To overcome the problem of multicollinearity, one can impose a restriction on the variables. Factor analysis can efficiently perform this task by transforming the correlated ratios into orthogonal factors that are completely independent from every other factor. These factors can be used as independent variables. In addition, the factor analysis technique can reduce the number of ratios into a reasonable number. Furthermore, the method is an objective one for selecting the independent variables. Finally, the factor solution increases the interpretation of data through the factor scores.

A survey of the ratios prevailing in the finance and accounting literature revealed those identified in Table II.

Factor Analysis

The main objective of factor analysis and principal components is to determine the structural relationships of multidimensional data where no theoretical relationship exists. The essential characteristic of factor analysis is its ability to sort a set of variables into subsets, so that each subset contains variables that are as similar as possible. These subgroups are known as factors. Thus, the primary use of factor analysis is to reveal the factor structure of financial statement ratios so that the lowest possible number of independent variables can be used in the regression equation and the multicollinearity can be reduced or eliminated.

The Underlying Assumptions

The role of factor analysis can be clarified by a simple example. Assuming that there are three standardized variables: X, Y, and Z, the goal of factor analysis is to summarize, under certain restrictions, most of the information in X, Y, and Z with less than three variables. Assuming this can be accomplished with two new hypothetical variables V

TABLE II

LIST OF RATIOS TESTED

(1) Cash Flows/Sales
(2) Gross Profit/Sales
(3) Net Income/Sales
(4) Cash Dividends/Net Income
(5) Current Liabilities/Net Worth
(6) Debt/Net Plant
(7) Debt/Total Capital
(8) Working Capital/Total Assests
(9) Debt/Net Worth
(10) Receivables/Inventory
(11) Cash/Total Assets
(12) Cost of Goods Sold/Current Liabilities
(13) Current Assets/Total Assets
(14) Current Assets/Current Liabilities
(15) Inventory/Current Liabilities
(16) Inventory/Working Capital
(17) Quick Assets/Total Assets
*(18) Quick Assets/Current Liabilities
*(19) Receivables/Sales
(20) Total Assets/Sales
(21) Total Current Assets/Sales
(22) Inventory/Sales
*(23) Quick Assets/Sales
(24) Cash Flow/Total Assets
(25) Cash Flow/Net Worth
(26) Cash Flow/Debt
(27) Net Income/Total Assets
(28) Net Income/Net Worth
(29) Sales/Net Worth
(30) Sales/Working Capital
(31) Sales/Total Assets
(32) Cost of Goods Sold/Inventory
(33) EBIT/Total Assets
(34) EBIT/Sales
(35) Fixed Charges/EBIT
(36) Sales/Net Plant
(37) Growth rate=ln Terminal asset size(77)/initial size(76)
(38) Leverage=Total Senior Securities(including Current Liabilities)/Total Assets
(39) Times interest earned ratio=Pre-tax earnings+ Interest expense/interest expense
(40) Fixed Assets/Total Assets

*It is expected that the amount of each of these ratios only will be constant under the three models investigated.

and W, then the relationship between the original variables and the new ones will be as follows:

$$X_i = A_{xv} \; V_i + A_{xw} \; W_i + U_x$$

$$Y_i = A_{yv} \; V_i + A_{yw} \; W_i + U_y$$

$$Z_i = A_{zv} \; V_i + A_{zw} \; W_i + U_z$$

The X_i, Y_i, and Z_i represent the observable original data. The A's represent the factor loadings, which are the correlations between the unobserved latent variables (V_i, W_i) and the standardized variables (Z or Y or X). The U's represent the difference between summarized and actual values of X, Y, and Z. The factor scores (V_i and W_i) are developed in such a manner as to explain the maximum common variance between the observed variables. The general form of factor analysis in matrix notation is:

$$X = \Lambda \; F + E$$

where:

X = observable variables,

Λ = factor loadings matrix

F = common primary latent factors

E = error term matrix

This study is based on certain general assumptions and specific assumptions related to factor analysis. The <u>general</u> assumptions are:

1. Investors have a long-term investment horizon.
2. Investors are rational and risk-averse, ie., rational investors prefer more returns for the same amount of risk or same amount of returns for less risk.
3. Returns of securities are linearly related to the market return in the market model.

4. The theory supporting the market model assumes a positive relationship between expected return and risk, so the market return should be greater than the return on a risk free portfolio.

The relationship between factor scores and observable variables in principal component analysis is based on the following <u>specific</u> assumptions or restrictions:

1. The first Y's to be computed have the largest possible variance; hence, $Var(Y_1) > Var\ (Y_2) > \ldots\ Var(Y_p)$.
2. The coefficient vectors must have a unit length (i.e., $\underset{\sim}{a}'_i\ \underset{\sim}{a}_i=1$).
3. $Y_1, Y_2, \ldots, Y_p$ should be completely linearly independent (i.e., orthogonal). That is, the coefficient vectors should satisfy ($\underset{\sim}{a}'_1\ \underset{\sim}{a}_2=0$).
4. The variance of each factor equals the corresponding eigen vector, i.e., $Var(Y_i) = \lambda_i$.
5. The total variance of the observable variates equals the total variance of the new latent factors,

$$\sum_{i=1}^{p} Var\ (X_i) = \sum_{i=1}^{p} Var\ (Y_i).$$

6. The Y's are independent, with a mean of zero and a unit variance.
7. The distribution of variables under study must be normal (Harman, 1967).
8. Harman (1967) also states that observed variables must be related to one another.

Factor Loading

In factor analysis, a Factor score is defined as a linear combination of the observed variables:

$$F_i = a_1 X_{1i} + a_2 X_{2i} + a_3 X_{3i} + \ldots + a_n X_{ni}$$

where: F_i = factor score for i = 1,..., r factors

a_j = factor loading for i = 1,..., n variables

X_{ji} = observed variable for j = 1,..., n.

The factor loading (a_i) explains the correlation between the factor score (F) and the observed score on each variable (X). If there are n variables and r factors, then the dimension of the factor loading matrix will be (n x r) factor loadings.

The factor loadings serve as the basis for analyzing the factor structure. The pattern of the factor loadings will be used as an attempt to describe the nature of the underlying structure of the data.

If the loadings of each factor are squared and summed, the resultant "sum of squares" will equal the eigenvalue of the factor. Each eigenvalue is equal to the variance accounted for by the factor. The percent of total variance accounted for is computed by dividing the eigenvalue by the total variance for all observations of all variables.

The Uses of Factor Scores

The total number of possible factor scores is always equal to the total number of variables. In order to create a factor score (F), each variable (assume Z) is weighted proportionally to its involvement on a factor. A high factor loading would be associated with a high weighting (W). To determine the score for a firm on a factor, the firm's data (i.e., the ratios) for each variable are multiplied by the factor weight for that variable. In matrix notation, the factor score would be:

$$F_{n \times f} = Z_{n \times v} W_{v \times f}$$

where:

n = the number of observations (firms)

f = the number of factors

v = the number of variables (ratios)

$F_{n \times f}$ = score on n firms of f factors

$Z_{n \times v}$ = standard score data matrix for n firms on v ratios

$W_{v \times f}$ = weights multiplied by the v ratios to obtain the factor scores

After computing all the factor scores, two alternative approaches could be applied regarding the NATURE of the independent variables to be used in the study. It is possible to either select a single ratio (for example the ratio which has the highest representation on each factor) or to select a composite variable reflecting the influence of more than one ratio. This composite variable is known as a factor score.

Short (1973) has supported the use of the composite variables concept for factor scores:

> The factor score is intutively appealing in the sense it includes the influence of all the ratios which appear to measure a financial concept rather than just a single ratio's influence (p. 54).

In the present study, the analysis used the composite factor scores.

When to Stop Factoring

It is always possible to get a number of factor scores equal to the number of variables. The factor analysis technique usually extracts the largest and most interesting combinations of variables first and then proceeds to smaller combinations. As the analysis proceeds the variance accounted for becomes smaller and smaller and the factors become less interpretable.

Four different criteria can be employed to determine when to stop factoring. First, when the analyst already knows enough about his data so that he knows how many factors are actually there, he can stop the analysis after that number of factors has been extracted. Second, if he has a clear idea in advance about the amount of variance the factor can explain, he can stop when that criterion is reached. The third criterion is an incremental approach. After a first set of factors has explained a large percentage of variance, say 75%, if the next factor adds only a small percentage of total variance, say less than five percent, it may be discarded and factoring stopped. The final criterion, Kaiser Criterion (Rummel, 1970), is most popular due to its objectivity. It states that all factors whose eigenvalues are greater than one can be considered as significant and meaningful factors. Since a squared loading is the amount of a variable's variance which is explained by a factor, the sum of all the squared loadings on a factor is the amount of variance explained by a factor. When standardized variables are used, the variance of an individual variable is one. Therefore, if the sum of squared loadings on a factor is less than one, that factor explains less variance than is added by a single variable.

At this point, factoring should be stopped. In this study, the Kaiser criterion was used.

Rotation Techniques

Sometimes, the initial factor scores solution does not provide the analyst with a reasonable interpretation. This can occur when the generated factors are moderately correlated with many variables. The desired solution would eliminate these moderate correlations and highlight the interrelationship between the factor score and the variables. Such a solution may be obtained by rotating the initial factors so that their relationship to the original attributes changes. Axis rotation will, hopefully, generate a new factor structure that will have more meaning. Although the amount of variation associated with individual factors will be changed, axis rotation should keep the total portion of the variance explained by the initial factor solution as it was.

The impact of the rotation would be reflected in two results: (1) each variable will have either high or low loadings with a specific selected factor, (2) each factor will have a limited number of variables highly correlated with it. These two results facilitate the interpretation of the factor structure.

The mathematical derivation of rotation is not complicated. It is well known that an orthogonal transformation of uncorrelated variables results in uncorrelated variables. Further, if the coefficients producing the transformation are appropriately normalized, the variances of the original variables remain unchanged.

Assuming:

$X_{p \times n}$ = the new (transformed) factor scores

$F_{m \times n}$ = matrix of the initial factor scores m on the n units

$O_{m \times n}$ = any orthogonal matrix, $O' O = O O' = I$

$A_{p \times m}$ = correlation between X and F

$E_{p \times n}$ = Error term

Then:

$$X_{p \times n} = A_{p \times m} F_{m \times n} + E_{p \times n}$$

$$X_{p \times n} = (A_{p \times m} O'_{m \times m}) (O_{m \times m} F_{m \times m}) + E_{p \times n}$$

$$X_{p \times n} = \quad C \quad \cdot \quad F^R \quad + E_{p \times n}$$

The new factor matrix, F^R, is also a linear transformation of the original X_i's. It is an orthogonal or rigid rotation (transformation) of the original factor axes. The most important result is that the association between the X's and the new rotated factor scores has been changed significantly from the initial model to the new one.

The simple structure rotation technique requires that the rotated factors contain many large and many zero loadings and only a minimum of intermediate values (Morrison, 1976). In practice, two main techniques prevail for rotations. First, orthogonal rotation approach which has three popular versions:

1. Varimax rotation strives to maximize the variance of squared loadings in each column in the factor pattern. Varimax is the most widely used technique because its results are always near the simple structure specifications.
2. Quartimax rotation strives to maximize the variance of the squared loadings in each row of the factor pattern.
3. Equamax represents the weighted average of both (1) and (2).

Second, another type of rotation technique exists which has a nonorthognal or oblique characteristic. The common version of this nonrigid transformation of the original axes is the Promax-oblique rotation.

In this study, Varimax and Quartimax orthogonal rotations were performed in order to evaluate the overall impact of the type of rotation used on the factor pattern of the data. This evaluation revealed the factor loading matrix that best reflects the nature of the intercorrelation among the independent variables (ratios). Then, the factor scores matrix belonging to the type of rotation technique selected were later used as an orthogonal substitute to the original correlated financial ratios for each of the accounting models under the study.

Hypotheses to be Tested

This study assumes that the equity investor has the choice of selection among the accounting alternatives: HC model, RC where holding gains are treated as income, and RC where holding gains are treated as capital adjustments. The study attempts to identify the more relevant financial model to his investment decision. The selection criterion was generally regarded as the explanatory power of each model (i.e., the corrected coefficient of determination of the multiple-regression model). Thus, the first hypothesis to be tested is:

> H_1: The coefficient of determination for the RC models will not be significantly different than the coefficient of determination for the HC model.

If the analysis of the results reveals that either of the RC models has a greater explanatory power (higher $\overline{R}^2$) than the others, it is important to know which specific financial ratios (under that model) caused the increase in the explanatory power. Revsine (1973) concludes his book with the following sentence: "A complete analysis of the reputed advantage of RC ratios would require an empirical determination of the specific ratios that are useful in risk assessment" (p. 186).

Schönemann and Carroll (1970) developed a technique to rotate one factor solution (known as the problem space) to achieve as close a congruence as possible with another factor solution (known as the target space). The purpose of this procedure is to minimize the impact of extraneous elements from influencing the comparison. The application of this technique in the present study required the rotation of each of the RC factor loading matrices until it becomes as similar to the historical data factor loadings matrix as possible. At this point, the rotated problem space matrix (either of the RC matrices) was subtracted from the target space (HC matrix) to produce a residual matrix for the number of factor scores retained. The sum of squares of the residuals in each row indicated which of the RC variables (i.e., ratios) that caused the significant change in the explanatory power.[2]

The hypothesis that indicated the impact of the changes of the measurement characteristics of individual ratios due to the RC adjustment process is as follows:

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[2]See Appendix B for a summary of the mathematical derivations of the Schonemann and Carroll technique.

> H_2: The factor structure of RC information will not be significantly different than the factor structure of the HC model for the same firms and the same study period.

The same hypothesis can be restated in the following empirical form:

> H_2: What are the specific financial ratios under each of the alternative accounting models that might have caused the significance difference in the explanatory power?

Finally, the analysis of the results might shed some light on the present controversy of the proper capital-maintenance concepts (financial vs. physical) to be adopted. If one of the three accounting models significantly outperforms the other in its explanatory power, this can be used as an evidence about the usefulness of either the financial or physical capital concepts in the risk assessment. Thus, the hypothesis concerning the association between the systematic risk and capital maintenance concepts is as follows:

> H_3: There is no significant difference in the explanatory power between the financial capital maintenance models and physical capital maintenance model.

The Criteria Used to Evaluate the Association

This study will use the multiple regression technique to regress the computed measure of the systematic risk (dependent variable) of each firm on the firm's financial accounting ratios (independent variables) computed first from the HC measures and second from RC measures. The criterion that will be used to evaluate the association and consequently the degree of explanatory power is the corrected coefficient of determination, $\overline{R}^2$, for each model. Statistically, R^2 is the ratio of explained variation to total variation of the dependent variable. R^2 is a measure of how well the regression equation describes the relationship between the variable. If R^2 is large, close to 1.0, a substantial amount of the variation in the dependent variable is explained by the independent variables. R^2 is widely used as a measure of the goodness of fit of the model used. The formula for R^2 is:

$$R^2 = \Sigma(\hat{Y}_i - \overline{Y})^2 / \Sigma(Y_i - \overline{Y})^2$$

$$= 1 - [\Sigma(Y_i - \hat{Y}_i)^2 / \Sigma(Y_i - \overline{Y_i})^2]$$

$$= 1 - [(\Sigma\hat{E}_i)^2 / \Sigma(Y_i - \overline{Y})^2]$$

where: Y_i = the observed dependent variable

$\overline{Y}$ = the mean of the observed dependent variable

$\hat{Y}_i$ = the predicted value of the dependent variable

$\hat{E}_i$ = prediction error

Pindyck and Rubinfeld (1976) explained the practical difficulty with R^2 as a measure of goodness of fit:

> R^2 pertains to explained and unexplained variation in Y and therefore does not account for the number of degrees of freedom in the problem. A natural solution is to concern oneself with variances, not variations, thus eliminating the dependence of goodness of fit on the number of independent variables in the model (pp. 54-61).

Therefore, they derived $\overline{R}^2$ (or corrected R^2) as follows:

$$\overline{R}^2 = 1 - [(1 - R^2)\frac{N-1}{N-K}]$$

where: K = No. of regressors including the intercept.

N = No. of observations.

In this study, it was expected that the number of observations would always equal fifty, while the number of the regressors (i.e., the factor scores) would be less than the number of the ratios (i.e., less than forty) therefore, $\overline{R}^2$ is used to evaluate the explanatory power of each model. Furthermore, the standard error of each model is used to evaluate the power of each model in addition to the main criterion ($\overline{R}^2$).[3]

As mentioned in Chapter I[4], this study - like most judgement analysis (JAN) studies - presumes a difference of (±.05) or more in the adjusted coefficient of determination to be significant.

Summary

The research variables have been identified and defined. Systematic risk of each firm is used as the dependent variable, while the firm's financial ratios (under three different accounting models) serve as the descriptors variables. Factor-analysis technique is employed not only to reduce the large number of independent variables but also to eliminate the existing intercorrelation among them. Finally, the research specific hypotheses and the criteria used to evaluate the degree of the association has been stated and clarified.

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[3]That is, a model with higher $\overline{R}^2$ and lower standard error will reflect the assessment of systematic risk better than another which has lower $\overline{R}^2$ and higher standard error.

[4]Refer to Chapter I, p. 12.

CHAPTER IV

RESULTS OF THE STUDY

The purpose of this chapter is to provide a detailed description of the empirical steps taken in evaluating the association between systematic risk and the three alternative accounting models. The first section explains the sample selection and data source procedures. The second section presents the results obtained from calculating the dependent variable (betas). The third section introduces the results of the calculation of financial ratios under the HC, RC1, and RC2 models and a discussion of the problems that emerged and how the research dealt with those problem. This section also presents the results of the use of factor analysis in the process of the transformation of financial ratios into orthogonal factor scores. The tests used and the analyses of the association between the market measure of risk and financial statement ratios are included in section four and divided into two parts: part (A) is concerned with the major, overall, and preliminary tests of the association, while part (B) specifies the accounting ratios that may have been responsible for the difference, in the association. Finally, the results chapter concludes with an overall summary.

Firms' Selection

The COMPUSTAT primary annual tapes were used to determine the firms that were subject to ASR #190 assets' size test and also had a fiscal year ending on December 31. There were a total of 745 firms representing most industries. A sample of 100 firms was randomly selected from the above population. Two preliminary tests were conducted on this sample. First, an examination was made to determine the availability of these firms on the CRSP tapes because the dependent variable (market beta) was to be computed from the data in the CRSP tapes. Second, the COMPUSTAT tapes were examined to make sure that accounting data needed to compute the financial ratios for the firms included in the sample population was not missing. The results were positive, all of the firms selected were on the CRSP tapes and all the required accounting information for the firms selected was on the COMPUSTAT tapes.

Finally, letters were sent to the sample firms requesting their annual reports and 10K forms for 1976 and 1977 fiscal years. Although the rate of response was high (almost 82%), only 50 of the firms disclosed unambiguous RC information. This research was confined to these 50 firms.

Calculation of Systematic Risk

As mentioned earlier in the methodology chapter, the independent variables (financial ratios) for the sample firms for 1977 were computed for three accounting models (HC; RC1; and RC2). Sytematic risk for the same firms over three basic periods (14, 12, and 10 months) were computed. Figure 1 shows the details of the periods used in computing the accounting ratios and systematic risk.

Period I: begins Nov. 1, 1977 to Dec. 29, 1978
Period II: begins Jan. 1, 1978 to Dec. 29, 1978
Period III: begins March 1, 1978 to Dec. 29, 1978

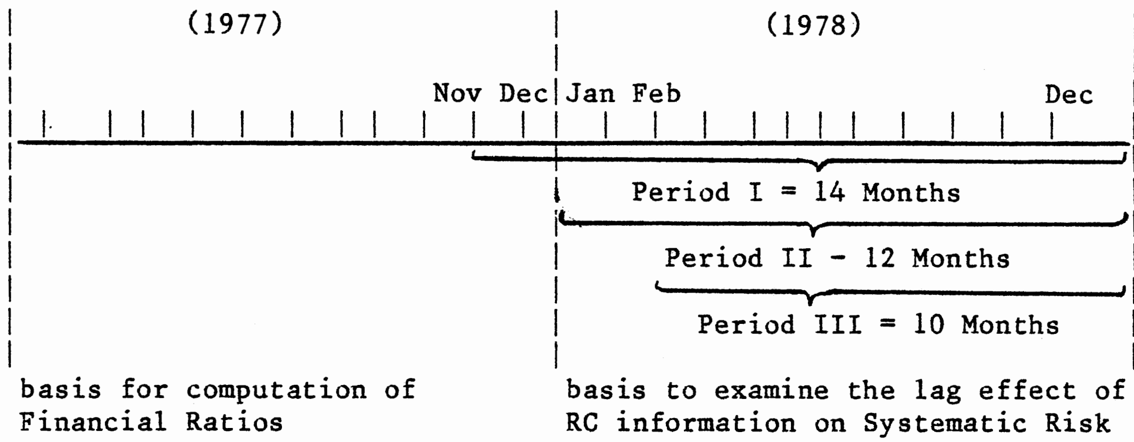

Figure 1. Periods Used in Computing Accounting Ratios and Systematic Risk

The Scholes and Williams (1977) technique was used to estimate the market betas. This technique compensates for bias in the estimation of the parameters in the market model. The results of the computation indicate, for each firm, that the beta estimates for periods II and III, are almost similar whereas the beta estimates for period I differ from the estimates for the other two periods.[1] These estimates of the market betas served as the dependent variable in the regression equations. The CRSP equally weighted market index ($\tilde{R}m$) was used in the calculation of systematic risk for the sample firms.

[1]Refer to Appendix C for results of systematic risk computations.

Developing Financial Ratios

Since the financial ratios are the independent variables in this study, a careful generation of these variables was crucial in order to assure accurate results. Twenty-one items of financial accounting data were required in order to generate the 40 financial ratios. Some of these accounting data are different under the three accounting models for the same firm. As mentioned in the research methodology, this research utilizes the financial data available on the COMPUSTAT annual tapes. Table III shows the accounting data used in generating the financial ratios.

COMPUSTAT annual tapes were used to compute financial ratios under the HC model, while the annual reports and 10K forms were used to compute the ratios for the two RC models. Eleven firms of the 50 sample firms were found to have zero amounts for cash, receivables, and inventory on the 1978 COMPUSTAT tapes. Although another more recent tape (1980) was available, the omissions were the same. Therefore, data from the specific financial reports of these firms were used to supplement the data on the tapes. For each firm, three sets of accounting ratios (HC, RC1, RC2 sets) were computed and used as inputs for the factor analysis experiment.

The Results of Factor Analysis

The main role of factor analysis is to depict the underlying structure of the data. Furthermore, factor analysis has the unique advantage of transforming the n sets of interdependent variables (40 Financial ratios in this study) into k sets of orthogonal variables

TABLE III

ACCOUNTING DATA USED IN FINANCIAL RATIOS COMPUTATIONS

COMPUSTAT No.	ACCOUNTING DATA
1	Cash and Short-Term Investment
2	Receivables (Net)
* 3	Inventories
* 4	Current Assets (Total)
5	Current Liabilities (Total)
*(6, 19)	Assets-Total/Liabilities and Net-Worth - year 1977
*(6, 18)	Assets-Total/Liabilities and Net-Worth - year 1976
* 8	Plant (Net)
9	Long-Term Debt (Total)
12	Sales (Net)
*13	Operating Income before Depreciation
*14	Depreciation and Amortization
15	Interest expense
16	Income-Taxes (Total)
*18	Income before Extraordinary Items and Discontinued Operations
*41	Cost of Goods Sold
49	Minority-Interest (Income Account)
*60	Common Equity (includes: common stock, capital surplus and retained earnings)
75	Liabilities (Others)
127	Cash Dividends (Statement of Changes in Financial Position)
130	Preferred Stock (Carrying Value)

*The accounting data has different amounts under the three accounting models (where $k < n$). Thus, factor analysis served two purposes in this research. First, the transformation of the 40 financial ratios into orthogonal factor scores which were used as independent variables thereby eliminating multicollinearity in the independent variables. Second, factor analysis, as most multivariate techniques, served as a data reduction tool (i.e., the number of independent variables was reduced).

As discussed in the research design chapter, the Kaiser criterion was adopted as an aid to determine the point to stop extracting additional factors. Under this rule of thumb, each factor whose eignevalue is greater than one is considered significant and hence retained as a meaningful factor. In this study only eight factors were found to be significant for the three accounting models. Nevertheless, the percentage of variation explained was approximately .91, .89, and .88 for the HC, RC1, and RC2 models, respectively.

As mentioned in the methodology chapter, two types of orthogonal rotation (varimax and quartimax) were utilized. The evaluation of the 3 factor loading matrices indicated that the quartimax rotation has the highest loadings, then the varimax, and finally the initial factor loading.[2] Therefore, quartimax factor pattern (loading) and its factor scores were used in the subsequent analysis as independent variable for each of the accounting models.

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[2]The output of factor analysis program for each accounting model provided three factor pattern (loadings) matrices: initial, varimax, quartimax.

The Factor Structure

Historical-Cost Factors. The factor structure for the HC model is presented in Table IV. The table includes only variables with substantial factor loadings (greater than .60). In some cases, factor loadings between .30 and .60 were also used to help interpret the factor structure.

In Table IV, although some factors appear to measure a definitive concept like liquidity, working capital and current position, others do not represent a clear concept. For example, factor one seems to represent some sort of activity measure since more than half of the ratios include sales. On the other hand, some other ratios in the same factor contain only asset or debt and asset measures. In factor two, five of seven significant ratios load positively with return while the other two non-return ratios load negatively. The other six factors have ratios that are more consistently identifiable with a single concept. Short (1977) has drawn attention to the problem of specifying a concept for a factor:

> . . . if many of the accounting ratios examined did not measure an underlying concept but merely had spurious correlations with others that did, it would be difficult to interpret a factor structure. Thus, it must be emphasized that this structure does not permit definitive conclusions to be drawn concerning what is being measured by accounting ratios (pp. 82-83).

Replacement-Cost Factors. The factor structure for RC1 is shown in Table V. A comparison of RC1 factor structure and HC one reveals that the HC size factor represents assets divided by sales or income or assets whereas under the RC1 factor the denominator is total assets in all cases. The total assets/sales ratio has dropped out. On the other

TABLE IV

FACTOR STRUCTURE OF HISTORICAL RATIOS

Factor One-Size			
Cash Flows/Sales	(-.93)	Total Assets/Sales	(-.88)
Net Income/Sales	(-.81)	Sales/Net Worth	(.84)
Debt/Plant	(.65)	Sales/Total Assets	(.85)
Working Capital/Total Assets	(.65)	EBIT/Sales	(-.93)
Current Assets/Total Assets	(.79)	Sales/Plant	(.80)
Quick Assets/Total Assets	(.73)	Fixed Assets/Total Assets	(-.85)
Factor Two-Return			
Debt/Total Capital	(-.61)	Net Income/Net Worth	(.74)
Cash Flow/Total Assets	(.91)	EBIT/Total Assets	(.95)
Cash Flow/Debt	(.92)	Total Senior Securities	
Net Income/Total Assets	(.96)	(including current liabilities/Total Assets	(-.75)
Factor Three-Inventory Turnover			
Inventory/Sales	(.83)	C.O.G.G.S./Inventory	(-.85)
Factor Four-Financing Policy Cleverage			
Cash Dividends/Sales	(-.62)	Debt/Net Worth	(.73)
Cash Flow/Net Worth	(.95)		
Factor Five-Liquidity			
Debt/Total Capital	(.62)	C.O.G.S./Current Liabilities	(-.56)
Current Assets/Total Assets	(-.56)	Quick Assets/Current Liabilities	(-.56)
Factor Six-Working Capital			
Inventory/Working Capital	(.95)	Sales/Working Capital	(.95)
Factor Seven-Capital Intensiveness			
Cash/Total Assets	(.48)	ln(Assets end 77/Asets end 76)	(.95)
Factor Eight-Current-Position			
Cash/Total Assets		Receivables/Sales	(.74)
Current Assets (Total)/Sales	(.74)	Quick Assets/Sales	(.90)

TABLE V

FACTOR STRUCTURE OF RC1 RATIOS

Factor One-Size

Working Capital/Total Assets	(.95)	Current Assets/Total Assets	(.96)
Quick Assets/Total Assets	(.91)	Cash Flow/Total Assets	(.94)
Net Income/Total Assets	(.73)	Sales/Total Assets	(.96)
EBIT/Total Assets	(.95)	ln(Assets end77/Assets end76)	(-.95)
Total Senior Securities (including current assets)/Total Assets	(.85)	Fixed Assets/Total Assets	(.91)

Factor Two-Liquidity

C.O.G.S./Current Liabilities	(.88)	Current Assets/Total Liabilities	(.86)
Inventory/Current Liabilites	(.83)	Quick Assets/Current Liabilities	(.74)
Total Assets/Sales	(-.63)		

Factor Three-Working Capital

Cash Flows/Sales	(.69)	Net Income/Sales	(.81)
Inventory/Working Capital	(.90)	Net Income/Net Worth	(.61)
Sales/Working Capital	(.90)	EBIT/Sales	(.70)

Factor Four-Financial Policy Cleverage

Current Liabilities/Net Worth	(.91)	Debt/Plant (net)	(.93)
Debt/Total Capital	(.88)	Debt/Net Worth	(.74)
Total Assets/Sales	(-.62)	Sales/Net Worth	(.81)
Sales/Plant (net)	(.66)		

Factor Five-Current Position

Receivables/Sales	(.77)	Current Assets (Total)/Sales	(.83)
Quick Assets/Sales	(.91)		

Factor Six-Return

Gross Profit/Sales	(.60)	Cash/Total Assets	(.66)
Cash Flow/Debt	(.69)		

Factor Seven-Inventory Turnover

Receivables/Inventory	(-.78)	Inventory/Sales	(.79)
COGS/Inventory	(-.74)		

Factor Eight-Capital Intensiveness

Cash Dividends/Sales	(.51)	Net Income/Total Assets	(.34)
COGS/Inventory	(.50)	Fixed Changes/EBIT	(-.68)

hand, the return factor of HC has 6 financial ratios highly loaded on it, while the return factor under RC1 has only two ratios which loaded moderately. With respect to the other factors there are no significant differences between the HC and RC1 accounting models. Finally, the factor structure of the RC2 model is not significantly different from the RC1 factor structure. This may be due to relatively small changes in the unrealized holding gains and losses during 1977.

Evaluation of the Association

Preliminary Tests of the Association

In order to evaluate the degree of the association between systematic risk calculated under the three periods mentioned in the methodology chapter and the three orthogonal factor scores (as representative of the ratios) rotated by the quartimax technique, nine multiple regression were performed and their results are as shown in Table VI.

The overall results are consistent. The HC model has greater explanatory power as measured by the coefficient of determination than the two RC models. In addition, the difference in the explanatory power is significant (because it is $>|.05|$). Although the coefficient of determination declines for the two periods beginning after the close of 1977, the HC model continued to outperform the two RC models. Furthermore, the standard error of the HC model is the lowest in all the periods as compared to the standard error of RC1 and RC2 models.

TABLE VI

RESULTS OF REGRESSING BETAS ON FACTOR SCORES USING THE COEFFICIENT OF DETERMINATION AND STANDARD ERROR

Accounting Model / Period of Calculating Betas	I 14 Months Nov. 77-Dec. 78	II 12 Months Jan. 78-Dec. 78	III 10 Months Mar. 78-Dec. 78
HC	.61** *.26	.56 .28	.56 .28
RC1	.55 .27	.51 .28	.51 .29
RC2	.53 .28	.49 .30	.49 .30

*standard error of the model

**the coefficient of determination (R^2)

Useful insights may be gained through an analysis of the contribution of each factor score in the overall explanatory power of each model (i.e., the contribution of each factor score in the total R^2). Period I has been chosen as a basis for investigating the individual factor score contribution because it has the highest explanatory power among all the periods. Table VII provides a breakdown of the contribution by factor scores. Notice that each amount represents the

TABLE VII

ANALYSIS OF R^2 BY FACTOR SCORES

Model	R^2	Size	Return	Inventory Turnover	Financial Policy	Liquidity	Working Capital	Capital Intensiveness	Current Position
HC	.61	.35	.00	.00	.17	.01	.00	.01	.07
RC1	.55	.03	.00	.02	.27	.10	.00	.00	.13
RC2	.53	.02	.04	.01	.23	.09	.00	.02	.12

individual factor contribution in the overall R^2 and not the percentage of contribution. Size, financial policy, liquidity, and current position are the major factor scores that contributed to the overall explanatory power of the accounting models. Specifically, size factor is better explained by the HC model than by the other two RC models, while financial policy and liquidity and current position are relatively better explained by RC1 and RC2 than by HC model.

Table VIII shows the explanatory power of the models utilizing the adjusted coefficients of determination ($\overline{R}^2$). The explanatory power of HC models is still greater than the two RC models when measured by ($\overline{R}^2$) and the standard error for each of the different periods for which beta was computed.

Identification of the Ratios that Possibly Caused Differences in Explanatory Power

In order to detect the financial ratios that caused the significance in the explanatory power between HC model and RC models, the analysis was restricted to period I since it reflects the highest explanatory power. Since it appears that there is no significant difference in the explanatory power of RC1 and RC2 models [the difference using R^2 or $\overline{R}^2$ is $<.05$], the analysis was restricted to HC and RC1 models under period I. The HC factor loading matrix was considered as the target matrix (B) while the RC1 factor loadings matrix was considered as the problem space matrix (A). The problem space matrix was rotated by several transformations (with the Schoneman and Carroll technique explaned in Appendix B) so that it would be as similar as possible to the target space. Then the residual matrix was computed by subtracting

TABLE VIII

RESULTS OF REGRESSING BETAS ON FACTOR SCORES USING ADJUSTED COEFFICIENT OF DETERMINATION AND STANDARD ERROR

Accounting Model / Period of Calculating Betas	I 14 Months Nov. 77-Dec. 78	II 12 Months Jan. 78-Dec. 78	III 10 Months Mar. 78-Dec. 78
HC	.53** *.26	.47 .28	.47 .28
RC1	.46 .27	.41 .28	.41 .29
RC2	.44 .28	.39 .30	.39 .30

*standard error of the model

**the adjusted coefficient of determination ($\overline{R}^2$)

the RC1 transformed factor loadings (problem space) from the corresponding factor loadings of the HC model (target space). The main idea is that the rows of the highest residual square (ε_i^2) represent variables that possibly caused the RC1 model to have a significantly smaller R^2 than the HC model. The residual factor matrix is shown in Table IX on page 67. The last column of Table IX shows the sum of squares from which an indication of the possible differences in the RC information can be found. The following are the ratios with a residual sum of squares greater than .50:

Variable (2)	Gross Profit/Sales	(0.83)
Variable (3)	Net Income/Sales	(0.52)
Variable (4)	Cash Dividends/Net Income	(1.24)
Variable (13)	Current Assets/Total Assets	(0.59)
Variable (17)	Quick Assets/Total Assets	(0.58)
Variable (25)	Cash Flow/Net Worth	(0.59)
Variable (28)	Net Income/Net Worth	(0.82)
Variable (38)	Total Senior Securities/Total Assets	(1.39)
Variable (40)	Fixed Asets/Total Assets	(1.54)

It is not surprising that these ratios appear to be responsible for the smaller R^2 for the RC1 model. Most of these ratios involve total assets or net worth. Since the measure of net worth and total assets would be different between HC and RC1 because of the holding gains included in the latter, one would expect that ratios which contain these measures would also be different.

Unfortunately, the reason why the HC model has a higher degree of association with the market's measure of risk (beta) than the RC1 model

TABLE IX

RESIDUAL FACTOR MATRIX

Variable	Factors 1	2	3	4	5	6	7	8	Sum Sq.
1	-0.2634	-0.1042	0.0539	0.0746	0.0409	-0.3396	-0.0875	0.0858	.22
2	-0.5938	0.2107	0.4649	0.2551	-0.0582	-0.0456	-0.2146	-0.3206	.83*
3	-0.2468	0.0758	0.0867	-0.4003	0.0613	-0.5288	-0.0792	0.0191	.52*
4	-0.5725	-0.4917	-0.1088	-0.7122	0.1582	0.2105	-0.2773	-0.0525	1.24*
5	-0.0702	-0.1934	-0.0838	0.3408	-0.0223	0.0158	-0.0095	0.1269	.18
6	0.2088	-0.0236	0.1110	-0.2324	0.1466	-0.0990	-0.2352	0.0864	.20
7	-0.2059	-0.2238	-0.0934	-0.0766	0.1732	0.0052	0.1040	-0.0995	.16
8	0.3170	0.0776	0.1940	-0.1778	-0.2014	0.1640	0.3550	0.2907	.45
9	-0.2935	-0.0923	-0.0170	0.3131	-0.1948	0.0291	-0.1182	0.0348	.25
10	0.0197	-0.0484	-0.0994	0.1812	0.0834	0.0603	-0.1632	0.0033	.08
11	0.0452	0.0515	-0.0954	-0.1079	-0.1730	0.0686	0.2533	0.1621	.15
12	0.0729	0.1281	-0.1577	0.1152	-0.1048	-0.0578	-0.1404	-0.2082	.14
13	0.4309	0.0287	0.1309	-0.1309	0.0331	0.1632	0.4735	0.3393	.59*
14	0.1084	0.1344	0.0584	-0.0332	-0.0877	-0.0334	-0.1503	-0.0447	.07
15	0.0405	0.1220	0.2029	0.0348	-0.0454	-0.0584	-0.1596	-0.1480	.11
16	0.2793	-0.1428	-0.1258	-0.0466	-0.0369	0.2973	-0.0673	0.0646	.21
17	0.3574	0.0134	-0.0544	-0.1712	0.0558	0.1615	0.4636	0.4216	.58*
18	0.1656	0.1084	-0.0639	-0.0856	-0.1080	0.0044	-0.1402	-0.0022	.08
19	0.0090	-0.0924	-0.0978	0.0061	0.0451	-0.0188	-0.2781	0.1047	.11
20	-0.2191	-0.1347	-0.0284	0.2655	0.0808	0.1158	-0.0075	-0.0278	.16
21	0.1447	-0.1323	0.0349	-0.1418	0.1055	0.0527	-0.0300	0.2029	.12
22	-0.0093	0.0154	0.1699	-0.0960	0.0444	-0.0313	-0.0830	-0.0071	.05
23	0.2072	-0.1738	-0.0443	-0.0888	0.1081	0.1116	0.0023	0.2687	.18
24	0.0545	0.4009	-0.0750	0.0618	-0.0797	0.1127	0.3854	0.0021	.34
25	-0.0573	-0.2419	0.0004	0.5744	-0.0309	-0.1664	-0.4167	-0.0077	.59*
26	0.1321	0.2577	0.0777	0.2395	-0.0800	-0.0731	-0.1985	-0.0852	.21
27	0.1126	0.3169	0.0060	-0.2583	-0.0456	-0.0313	0.1356	-0.0124	.20
28	0.1378	0.3052	0.0129	-0.6268	0.1171	-0.2198	-0.2772	-0.4168	.82*
29	0.1690	-0.0414	-0.0390	0.3171	-0.0292	-0.0860	-0.2242	-0.1735	.22
30	0.2821	-0.1451	-0.1221	-0.0407	-0.0369	0.3009	-0.0631	0.0591	.22
31	0.4548	0.0882	-0.1736	0.0092	-0.0684	0.1249	0.3991	-0.0960	.43
32	0.1366	-0.0297	-0.2934	-0.0141	0.0569	0.1046	-0.0690	-0.1077	.14
33	-0.0500	0.4181	-0.0415	0.0210	-0.0259	0.1234	0.3086	0.0561	.29
34	-0.2834	-0.1084	0.0570	-0.0098	0.0615	-0.3605	-0.1191	0.0783	.25
35	0.1802	0.1276	0.3388	0.2494	0.0413	-0.3220	-0.0675	0.0064	.34
36	0.1595	0.2601	0.1421	-0.0547	-0.0171	-0.1303	-0.3750	-0.0681	.28
37	0.1552	0.4098	0.1055	0.1427	0.0233	-0.1341	0.1223	-0.3441	.38
38	-0.5503	-0.8427	-0.1825	-0.0204	0.2142	0.1937	0.5044	0.0426	1.39*
39	-0.1261	0.2728	0.0622	0.3308	-0.1360	0.0637	-0.0436	-0.1468	.25
40	-0.8397	-0.5609	-0.3127	-0.0061	-0.0685	0.2523	0.5877	-0.0869	1.54*

*The variable is substantially different under RCI model as compared to HC one.

is less clear. There are at least three possible explanations. First, the market may not be relying on the reported unrealized holding gains and losses (the primary difference between the two accounting models) because such disclosures are unaudited, subjective estimates. Either the fact that such disclosures are mandated or subjective or both may significantly reduce the perceived information content.

Second, these measures are not disclosed in the same complete financial statement form as are the HC measures and must, therefore, be computed by the user of the statements. It is possible that this researcher's computations are different than those used by the market.

Third, the market simply may not use replacement cost data in its assessment of risk.

Summary

The major results of the research can be summarized as follows:

1. The explanatory power of the accounting models is higher at period I than period II or III.
2. The explanatory power of the HC model is significantly higher than RC1 or RC2. The coefficient of determination (adjusted and unadjusted) is highest and the standard error is lowest.
3. The factor scores that contribute the most to the R^2 are: size, financial policy, liquidity, and current position.
4. Factor analysis provides some insight into the concepts measured by accounting ratios, but the results were not unambiguous.

5. An analysis of the factor structure has shown that a limited number of ratios (9) may have caused the RC models to have a substantially smaller R^2 than HC.

6. The empirical results of this dissertation do not support Revsine's theoretical belief that RC financial ratios are more useful than HC ratios in assessing the risk associated with future flows.

7. Nevertheless, one cannot generalize based on the above empirical results that RC information as required by ASR #190 had no information content (i.e. had no benefit) to all categories of users. Truly the results showed that specific categories of traditional investors (e.g. sophisticated investments analysts, mutual funds managements, and life insurance company officers evaluating investments decision in debt or equity) rely mainly on HC signals more than RC ones in the prediction of the variability of the return of the securities (B) while preparing and monitoring their budgetary control, but another class of users (e.g. bank officers in their lending decisions, life insurance company officers evaluating direct or [private] placement, and bonds rating decisions) may actually find RC information more useful than HC one in their decisions.

CHAPTER V

IMPLICATIONS AND CONCLUSIONS

This final chapter of the research includes three main parts. The first is an evaluation of the research hypotheses in light of the empirical results and a summarization of the findings of the study. The second is a discussion of several limitations of the research. The third describes the implications of the study findings on future research.

General Evaluation and Summary of Research

This study investigated a new area in the association between accounting data and systematic risk. ASR #190 requirement to disclose replacement-cost information was the catalyst of the study. Fifty firms that were subject to ASR #190 were randomly selected from the population firms of the COMPUSTAT primary annual tapes. Forty accounting ratios (the independent variables in the study) were computed for each firm for the financial year ended 1977 under HC, RC1, and RC2 accounting models. The data was taken from COMPUSTAT tapes, form 10K, and annual reports. CRSP tapes were used in generating the market betas (the dependent variable of the study) under three different periods in order to examine the possible lag impact of RC information. Factor analysis was used to transform the correlated financial ratios into orthogonal factor scores and to reduce the number of independent variables in the regression equations. The orthogonal factors were used as regressors in the multiple regression tests. The corrected coefficient of determination ($\overline{R}^2$) and the standard error were used to evaluate the explanatory power of each model.

Thus, nine regression models (described in Chapter III) were developed to test the following main hypothesis:

> H_1: The coefficient of determination for the RC models will not be significantly different than the coefficient of determination for the HC model.

All the empirical results confirmed the prevailing notion that the investors use nonaccounting data in addition to accounting data in their evaluation of systematic risk. The maximum amount of the coefficient of determination (R^2) obtained was (.61) and the maximum amount of the adjusted coefficient of determination ($\overline{R}^2$) was (.53).

The results of the research - as shown in the preceding chapter - indicated generally that there is a substantial difference in the explanatory power of the two RC models as compared to the HC model. The explanatory power of the HC model was greater than the two RC models in each of the three periods. There was no substantial difference in the explanatory power between the two RC models.

Different justifications may account for the lower explanatory power of the RC models. First, since the accounting data used to generate the financial ratios are the amounts of income before extraordinary items and discontinued operations and the amounts of total assets (and consequently net worth), the differences between the HC and RC1 ratios appears to be attributed to the amounts of changes in unrealized holding gains and losses during the year of study. It may be that investors do not trust the estimation of holding gains and losses included in the RC information. This lack of trust might also be caused by the use of the title [RC information - unaudited]. Second, some of the replacement cost measures must be computed from data taken from more than one source. It may be that the market's computations of the RC measures are different than those used in this study. Third, it may be that the market simply does not use RC data in its assessment of risk.

The empirical results of this research support the position that investors still use the traditional HC model in the process of evaluating the risk of their investments.

The explanatory power of the general price accounting model in Short (1977) study was higher than that of the HC model, while the reverse occured in this study when specific price changes models were used. Both studies used systematic risk as a dependent variable and both studies were conducted during an inflationary period. The difference in the results may be due to the fact that Short used his own estimates of general price level accounting data, whereas this study used the actual release of ASR #190 information. In addition, there are basic differences in the alternative accounting models examined in each study. The purchasing power gain or loss on net monetary items were included in the alternative accounting model examined in Short's study but not in this study, and the unrealized holding gains and losses, were included in the alternative accounting model in this study but not in Short's study. Furthermore, Short indicated that his use of monthly beta included an error. This error could have resulted in a biased measure of explanatory power. The present research attempted to overcome this error in the dependent variable by using Scholes and Williams (1977) technique.

The second hypothesis tested in this research is:

> H_2: The factor structure of RC information will not be significantly different than the factor structure of the HC model for the same firms and the same study period.

The mathematical results of the examination of the factor loading matrices of HC and RC1 models indicated that nine of the forty financial ratios experienced a significant change in their factor loadings and might have caused the substantial differences in R^2 and the standard error. These ratios have a common feature of activity or size measures, i.e., the denominator is always sales, or net worth, or assets. Thus, the nine ratios detected can be considered as a possible reason of the significant difference between the factor structure of HC and RC1.

Finally, the hypothesis concerning the association between the systematic risk and capital maintenance concepts (financial vs. physical) could not be resolved within the data and results of this research because the difference in the explanatory power between RC1 model and RC2 model was not substantially different (i.e., it was less than $|0.05|$).

Limitations

There are several limitations in the generalizability of the findings of this study. First, due to the wide variety of alternative historical-cost accounting procedures and measurements used by firms when reporting similar economic conditions (especially for inventory and depreciation methods), there may be an error in the measurement of the independent variables. The limitation might cause bias in the explanatory power under HC model. Second, RC estimates contain an undetermined amount of subjectivity which might cause some noise to the data used. Third, since judgement was involved, the design and implementation of the factor analysis experiment was not completely precise. For example, Kaiser criterion was used in selecting the factors to be used as independent variables in the regression equations. The use of this rule of thumb probably caused the omission of some accounting information which may be used by the market. Fourth, the multiple regression models have omitted some variables. Since market risk is a function of both accounting and nonaccounting information, a failure to include nonaccounting information in the regression models resulted in an overall decrease in the explanatory power of <u>all</u> the models. Fifth, the adjustments and procedures used in this study to determine the valuation of the RC estimates of assets which are not to be replaced may not be the same as those used by the market. Nevertheless, this empirical study has shed new light on the ability of the HC accounting model to describe and predict the market measure of systematic risk, and it has cast doubt about the desirability of disclosing RC information.

Future Research

This research should be replicated on an industry by industry basis. Certain industries whose financial statements may be greatly affected by different accounting models (e.g., the magnitude of the difference between HC and RC statements for utilities) should be examined to determine if the relationship between accounting data and systematic risk differs between industries. Additionally, information disclosed in accordance with SFAS No. 33 (Financial Reporting and Changing Prices) could be used as the base for a new study which would have the unique advantage of simultaneously testing the association between beta and accounting data disclosed under the HC, constant dollar, and current-cost models.

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APPENDIXES

APPENDIX A

REPLACEMENT-COST ESTIMATION AND

ADJUSTMENTS PROCEDURES

In March 1976, the SEC required certain non-financial firms to report (in both published annual and 10K reports) selective replacement-cost information if they meet a specific assets' size test for fiscal years ending after December 24, 1976 (ASR #190). This release is applied to large publicly-held firms where:

(a) Total inventories, gross property, plant and equipment is larger than $100 million, and

(b) The total of inventories, gross property, plant and equipment is larger than 10% of total assets.

The required specific replacement-cost information can be grouped into two main categories.

Assets

For each fiscal year for which a balance sheet is presented, the following must be disclosed:

(a) The current gross replacement-cost of year-end inventory, and its excess, if any, over net realizable value.

(b) The estimated current-cost of replacing (new) the productive capacity together with the current replacement-cost of depreciable, depletable, or amortizable assets net of accumulated depreciation so as to adjust for services potential used in prior periods.

Costs and Expenses

For the two most recent fiscal years, the following must be disclosed:

(a) The approximate amount that cost of sales would have been if it had been calculated by estimating the current replacement-cost of goods and services sold at the times when the sales were made.

(b) The approximate amount of depreciation, depletion, and amortization that would have been recorded if it were estimated on the basis of average current replacement-cost of productive capacity.[1]

In order to generate the financial statements (mainly the income statement and the balance-sheet) for the study period (year 1977) for each of the fifty sample firms under the HC, RC1, and RC2 models, a pilot study was first done on ten firms to evaluate the practical feasibility of creating replacement-cost models. The results of the test were positive with a few minor problems. A few assumptions were needed to provide a comprehensive replacement-cost models which simultaneously overcome these minor problems.

First, since this study is based on utilizing the historical cost financial data of sample firms which are available on the COMPUSTAT tapes, whereas the source of replacement cost data consisted of annual reports and form 10K's for the years ending December 31, 1976 and December 31, 1977, it was necessary to adjust the financial items content under the two replacement-cost models to agree with the definition and interpretation of the COMPUSTAT manual. For example, most firms provide in the income statement the gross amount of the cost of goods

[1]U.S., Securities and Exchange Commission, SEC Docket, Washington, D.C., 23 March 1976, pp. 241-244.

sold (including depreciation, depletion, and amortization), while the definition of cost of goods sold in the COMPUSTAT ANNUAL DATA (item 41) excludes the depreciation, depletion, and amortization allocated to cost of goods sold. This difference in the definitions of cost of goods sold not only impacts on total operating cost but also on the operating income before depreciation. Thus, a uniform definition of the financial items used in this study was not only essential but a necessary requirement for reasonable comparisons among firms under the three accounting models used.

Second, where the components of the main financial data are scattered in the income statement or the balance-sheet or the statement of changes in the financial position or the notes to financial statements, the financial items were grouped within the COMPUSTAT definitions for these items. For example, cash dividends to stockholders [item 127] have been grouped on the COMPUSTAT definition which includes dividends to preferred stockholders and dividends to common stockholders.

Third, the preliminary pilot-study explicitly revealed that for the majority of firms the management policy was not to replace completely its assets (especially the net amount of property, plant, and equipment). For example, if a firm has property, plant and equipment (net) for $85 million as an asset item, it usually provides a replacement-cost estimation for only a portion of the historical net amount (say for $78 million). This reporting procedure is quite correct and legal as long as the management's policy is to replace this portion only in the future. The remaining amount ($7 million in this example) usually represents the amount of land and the amount of property, plant, and equipment that the management does not intend to replace. Thus, an objective adjustment procedure was required in order to provide a total estimate of the replacement-cost of the property, plant, and equipment and other similar items for which no replacement-cost amount was provided.

Fourth, the main financial items that required estimations and adjustments procedures under the two replacement-cost models were as follows:

(1) Cost of goods sold [excluding depreciation] during 1976, 1977.
(2) Selling, general, and administrative expenses [excluding depreciation] during 1976 and 1977.
(3) Depreciation, depletion, and amortization during 1976 and 1977.
(4) Inventories at the end of the years 1976 and 1977.
(5) Property, plant and equipment at the end of the years 1976 and 1977.

Although rule 3-17 of regulation S-X requires reporting of the above replacement-cost data within these requirements, certain assets are exempted from these reporting requirements.

Types of Adjustments

Two main types of adjustments were made.

Type I Adjustments

Certain assets and expenditures have no required reporting replacement-cost estimates. Fixed assets that would not be replaced, e.g., land, construction in progress, and mineral resources assets, are examples of these exemptions.[2] Replacement-cost estimates for these

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[2]U.S., Securities and Exchange Commission, Regulation S-X, Rule 3-17, Washington, D.C.

related historical-cost portions was computed on the assumption that differences in inflation rates do not significantly affect the overall relationship between the historical-cost and the replacement-cost for the same firm. A firm specific factor has been generated which takes in consideration the overall impact of the inflation on the firm's assets (inventory and property, plant, and equipment) and the firm's expenditures (cost of goods sold and selling, general, and administrative expenses 'excluding depreciation' and depreciation, depletion and amoritzation). This factor has been built for each specific firm for 1976 and 1977.

Thus, for each item which falls in this group:

$$\text{Replacement-cost adjusted amount} = \frac{\text{Total reported replacement-cost}}{\text{Total historical-cost to which reported replacement-cost applied}} \times \text{Unreported portion of historical-cost of assets or expenditures}$$

Type II Adjustments

Some items are not reported at their replacement-cost, at all, e.g., income taxes, minority interest in income, interest expense, and construction in progress. Generally, for these items, historical-cost amounts approximate their replacement-costs.

The above adjustments were consistently applied to the financial data of the fifty firms in the sample. When detailed and sufficient information were not available or when ambiguity existed in the annual reports or the 10K's, the firm was excluded from the study. Almost 25% of the respondent firms [20 of 80] were excluded due to nonavailability or ambiguity of the information provided.

The main emphasis in the building process of the financial statements for the sample firms under the three accounting models was on the significant impact of the type of the accounting model used on the following items:

(1) Income before extraordinary items and discontinued operations (Item number 18 on COMPUSTAT).

(2) The amount of the common stock equity (Item number 60 on COMPUSTAT).

In addition, the following financial items, either in the Income-statement or the Balance-sheet, are significantly affected by the estimation and adjustments process:

	COMPUSTAT Number	Name
I. Income Statement items	41	Cost of Goods Sold
	(12 - 13 - 4)	Selling, General and Administrative Expenses
	13	Operating Income before Depreciation
	14	Depreciation, Depletion, and Amortization
	18	Income before Extraordinary items and Discontinued Operations
II. The Balance Sheet	3	Inventories
	4	Current Assets (Total)
	8	Plant (net)
	6	Assets (Total)/Liabilities and Net Worth (Total)
	60	Common-Stock Equity

The accounting design of the first replacement-cost model (RC1) required the utilization of two new income statement accounts which represent the main features of this model. Specifically, accounts for realized holding gains and losses and changes in cumulative unrealized holding gains and losses were created under replacement-cost model one (RC1). In addition, the second replacement-cost model (RC2) requires the use of a new balance sheet account, called the "Revaluation Reserve," account as a sub-account of common-stock equity.

Finally, the extraordinary items and the gain or loss on discontinued operations have been initially eliminated from the historical-cost model and consequently from the other two replacement-cost models as well. This elimination is based on the assumption that these two items do not reflect the operating activites of the firm, and therefore, it is unlikely to affect the judgment of the long-term investor in his investment decision. Thus, it was hoped that the elimination of these items would eliminate a source of noise in the computation and evaluation of the explanatory power of the alternative accounting models among the firms in the example.

Generally, according to ASR #190 requirements, the following HC items have been adjusted to represent the two RC models:

I. Holding Gains treated as an income item:

(Model 1: realization concept ignored)

A. Income Statement Adjustments

1. HC of goods sold and depreciation expense for the period under study have been replaced by RC of goods and services sold and RC depreciation as actually reported in the 10K and annual reports of the firms.

2. Realized and unrealized holding gains in each period was treated as income.

B. Balance Sheet Adjustments

1. Inventory and depreciable assets (net of accumulated depreciation) were replaced by the comparable amounts under RC models as provided in each firm's supplementary information.

2. The income-tax expense was assumed to be identical under the three accounting models used.

3. Retained earnings was adjusted for the change in net income figure.

II. Holding Gains considered as a capital adjustment:

(Model 2: Holding Gains-Capital Adjustment)

A. Income Statement Adjustments

1. (same as I-A-1 above)

2. Realized and unrealized holding gains for each study period were not treated as income. Thus, current operating profit always equals net income.

B. Balance Sheet Adjustments

(1, 2, and 3) same as I-B-(1, 2, and 3) above.

4. A new equity account was created under the title of (Revaluation Reserve) and was attached to the common stock equity.

Since, the adjustments from HC to RC affected only the non-monetary items (inventory/cost of goods sold, property plant and equipment/depreciation expense/accumulated depreciation etc..), monetary items were not adjusted in this study.

Example

The following example of the RUBBERMAID INCORPORATED illustrates the impact of the accounting models used (HC, RC1, and RC2) on the financial statements for the year ending December 31, 1977. The main effect is quite clear on the Income before extraordinary items and discontinued operations and on the total assets.

Three main checks were used among the three models:

(1) Historical-cost income = Income before Extraordinary items and discontinued operations (RC1) + Realized holding gains and losses

(2) Assets under RC1 and RC2 = HC assets + Difference between RC and HC of inventories + Difference between RC and HC of Property, Plant and Equipment (net)

(3) Common Stock Equity Under RC1 and RC2 = Common Stock Equity under HC model + (Total assets under RC1 or RC2 - (Total assets under HC model)

CONSOLIDATED STATEMENTS OF EARNINGS
Rubbermaid Incorporated and Subsidiaries

Years ended December 31, 1977 and 1976

	1977	1976
Net sales	$226,484,000	186,222,000
Deduct cost of sales and operating expenses:		
Cost of sales (note 2)	149,818,000	122,966,000
Selling, general and administrative expenses	42,645,000	36,094,000
	192,463,000	159,060,000
Operating earnings	34,021,000	27,162.000
Other charges (credits), net:		
Interest expense:		
Long-term debt	1,541,000	415,000
Other	108,000	77,000
	1,649,000	492,000
Interest income	(1,083,000)	(625,000)
Net exchange (gain) loss	664,000	(95,000)
Miscellaneous, net	83,000	51,000
Other charges (credits), net.	1,313,000	(177,000)
Earnings before income taxes.	32,708,000	27,339,000
Income taxes (note 10):		
Current	14,194,000	11,752,000
Deferred	1,620,000	1,690,000
	15,814,000	13,442,000
Net earnings	$ 16,894,000	13,897,000

CONSOLIDATED BALANCE SHEET
Rubbermaid Incorporated and Subsidiaries

December 31, 1977 and 1976

ASSETS	1977	1976
Current assets:		
Cash.	$ 846,000	890,000
Temporary cash investments, at cost which approximates market.	24,168,000	13,700,000
Receivables, less allowance for doubtful accounts of $337,000 in 1977 and $307,000 in 1976.	29,593,000	27,281,000
Inventories (note 2).	28,340,000	27,156,000
Prepaid insurance, taxes, etc..	1,380,000	880,000
Total current assets.	84,327,000	69,907,000
Property, plant and equipment, at cost less accumulated depreciation and amortization:		
Land.	1,488,000	1,488,000
Buildings and land improvements	35,680,000	30,825,000
Machinery and equipment	74,908,000	62,845,000
	110,588,000	93,670,000
Less accumulated depreciation and amortization	41,966,000	36,462,000
	68,622,000	57,208,000
Additions in progress	6,495,000	5,737,000
Property, plant and equipment, net	76,605,000	64,433,000
Other assets.	205,000	222,000
Excess of cost over net assets of accquired companies	1,268,000	1,271,000
Total Assets.	162,405,000	135,833,000

LIABILITIES AND SHAREHOLDERS' EQUITY	1977	1976
Current liabilities:		
Notes payable (note 4)	$ 997,000	648,000
Current installments of long-term debt (note 5).	568,000	563,000
Payables.	15,667,000	16,251,000
Accrued liabilites	8,071,000	6,718,000
United States and foreign income taxes.	4,856,000	3,959,000
Total current liabilities .	30,159,000	28,139,000

	1977	1976
Deferred income taxes	6,173,000	5,236,000
Deferred investment credit. . . .	2,645,000	1,962,000
Long-term debt, non-current installments (note 5)	20,800,000	10,589,000
Shareholders' equity:		
Preferred stock, without par value. Authorized 200,000 shares; none issued	--	--
Common Shares of $1 par value. Authorized 20,000,000 shares; issued 7,731,900 shares in 1977 and 7,731,772 shares in 1976 (note 6).	7,732,000	7,732,000
Paid in capital (note 6). . . .	20,805,000	20,803,000
Retained earnings (note 5). . .	74,091,000	61,372,000
Total shareholders' equity.	102,628,000	89,907,000
Total Liabilities and Shareholders' Equity.	$162,405,000	135,833,000

COMPARISON OF HISTORICAL-COSTS AND ESTIMATED REPLACEMENT COSTS

	1977		1976	
(000 Omitted)	Historical Cost	Estimated Replacement Cost	Historical Cost	Estimated Replacement Cost
December 31:				
Inventories.	28,340	35,800	27,156	33,600
Plant and Equipment (Excluding Land and Additions in Progress):				
Buildings and Land Improvements . . .	35,680	57,000	30,825	48,000
Machinery, Equipment and Molds.	74,908	106,000	62,845	90,000
	110,588	163,000	93,670	138,000
Less Accumulated Depreciation . . .	41,966	71,000	36,462	60,000
Plant and Equipment, Net.	$ 68,622	92,000	57,208	78,000
Year ended December 31:				
Cost of Sales. . . .	149,818	152,000	122,966	125,200
Depreciation:				
Included in Cost of Sales.	7,701	9,400	6,510	8,400
Other.	677	900	634	800
Total depreciation	$ 8,378	10,300	7,144	9,200

Estimation & Adjustments of HC Financial Statements to RC Financial Statements

	DNUM	CNUM	Serial #
Firm's Name RUBBERMAID INCORPORATED	3000.	781088.	38

(1)

CONSOLIDATED STATEMENT OF EARNINGS
FOR 1977

(THOUSANDS OMITTED)

	HC	RC1	RC2
SALES (net).	$226,484	226,484	226,484
(Cost of goods sold)	(142,117)	(142,600)	(142,600)
(S. G. & A. Expenses).	(41,968)	(41,968)	(41,968)
Other operating expenses			
Other Income (Net)			
Operating Income Before Depr .	$ 42,399	41,916	41,916
(Depreciation & Ammortization)	(8,378)	(10,300)	(10,300)
(Interest Expenses).	(1,649)	(1,649)	(1,649)
Nonoperating Income/Expense. .	(747)	(747)	(747)
Special Items.	1,083	1,083	1,083
Income Taxes (Total)	(15,814)	(15,814)	(15,814)
Minority Interest			
Income Before Extr. Items & Discontinued Operations. . .	$ 16,894	14,489	14,489
Realized H. G. & L.		2,405	
Changes in Unreal. H. G. & L.		3,590	
Income Bef. Extr. & Discont. .	$ 16,894	20,484	14,489

(2)

CONSOLIDATED BALANCE SHEET
AS OF DECEMBER 31, 1977

			HC	RC1	RC2
	ASSETS:				
	1	Cash & Short-Term Invest.......	25,014	25,014	25,014
	2	Receivables (net)..............	29,593	29,593	29,593
*	3	Inventories....................	28,340	35,800	35,800
	68	Current Assets (Others)........	1,380	1,380	1,380
*	4	CURRENT ASSETS (TOTAL).........	$ 84,327	$ 91,787	$ 91,787
*	8	Plant (net)....................	70,110	93,688	93,688
	73	Constructions in Progress......	6,495	6,495	6,495
	31	Invest. Uncons. Subs. (Equity).			
	32	" Others (Cost)..........			
	33	Intangibles....................	1,268	1,268	1,268
	69	Assets (Others)................	205	205	205
*	6	ASSETS (TOTAL).................	$ 162,405	$ 193,443	$ 193,443
	LIABILITIES:				
	5	Current Liabilities (total)....	30,159	30,159	30,159
	9	Long-term Debt (total).........	20,800	20,800	20,800
	75	Liabilities (Others)...........	8,818	8,818	8,818
	130	Preferred Stock................			
*	60	Common Stock Equity............	102,628	133,666	133,668
	6	LIABILITIES & NET-WORTH........	$ 162,405	$ 193,443	$ 193.443
	127	Cash Dividends to Stockholders	$4,175		

(Source for dividends is the consolidated statements of changes in financial position for 1977)

I. Calculation of Factors of RC Models:	1977 RC	1977 HC	1976 RC	1976 HC
Inventories...........................	35,800	28,340	33,600	27,156
Plant (net) (F.A. to be replaced).....	92,000	68,622	78,000	57,208
COGS..................................	142,600	142,117	116,800	116,456
Depreciation & Amortization...........	10,300	8,378	9,200	7,144
Others................................				
	$ 280,700	$ 247,457	$ 237,600	$ 207,964

	1977	1976
R C FACTORS........................	1,134,339	1,142,505
II. Plant (net):	RC (net)	HC (net)
1977: F.A. to be replaced..................	92,000	68,622
F.A. not to be replaced including Land	1,688	1,488
	$ 93,688	$ 70,110
1976: F.A. to be replaced..................	78,000	57,208
F.A. not to be replaced including Land	1,700	1,488
	$ 79,700	$ 58,696

III. Realized H.G.&L. During 77:	DIFF.	RC	HC
COGS..................................	483	142,600	142,117
S.G.&A. Expenses......................			
Depreciation & Amortization...........	1,922	10,300	8,378
	$ 2,405	$ 152,900	$ 150,495

IV. Net Changes in Cumulative Unrealized Holding Gains and Losses During 1977:	NET CHANGES	DIFF.	1977 RC	1977 HC	DIFF.	1976 RC	1976 HC
Changes in Cum. RC of Inventory at year end.........................	1,016	7,460	35,800	28,340	6,444	33,600	27,156
Changes in Cum. RC of P.P. & Eq. at year end............................	2,574	23,578	93,688	70,110	21,004	79,700	58,696
NET CHANGES...........................	3,590	31,038	129,488	98,450	27,448	113,300	85,852

V. Assets (Total) at end yr 76 at RC:	DIFF.		RC		HC
Inventories...........................	6,087		33,243		27,156
Plant (net)...........................	21,001		79,697		58,696
	27,088		112,940		85,852
Total Assets at RC end 76 (Data 6,18)	135,833	+	27,088	=	162,921

Remarks

(1) The left side number is the COMPUSTAT number.

(2) The extreme left sign (*) indicates that the amount of the financial item is expected to vary under alternative accounting models!

(3) DNUM = describes the Industry Classification Number of the company on the COMPUSTAT tape.

(4) CNUM = describes the CUSIP Company Number (Issuer Code) on the COMPUSTAT tape.

(5) Serial # = denotes the serial number of the company in the total sample of the research (50 companies).

APPENDIX B

FITTING ONE MATRIX TO ANOTHER UNDER CHOICE OF A CENTRAL DILATION AND A RIGID MOTION

The method presented has been designed for mathematically fitting a given matrix "A" (called here the problem space matrix[1]) to another given matrix "B" (called the target space matrix) by using the least square method to minimize the sum of squares of errors.

This technique was first presented by Shepard (1962), Kruskal's (1964-a, 1964-b), McGee (1966), and Guttman-Lingoes series (1967, 1968), and the solution in hand was developed by Schonemann and Carroll (1970).

The main feature of S-C technique is to apply several transformations on matrix "A" to obtain maximal agreement with the target matrix "B." That is, before one can get a meaningful comparison between matrix "A" and matrix "B," it would be necessary to rotate (changing the ordinates direction while the origin is still constant), translate (a shift in the origin), and centrally dilate[2] (a uniform expansion or contraction) the problem matrix "A" so as to obtain maximal agreement with the target matrix "B."

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[1]In the present study, one can assume that replacement-cost factor loadings matrix is the problem space "A", while traditional historical-cost factor loadings matrix is the target space "B".

[2]That is stretching or shrinking the scale.

Let us define:

A = known problem space matrix of dimension p x q

B = known target space matrix of dimension p x q

T = unknown orthogonal transformation matrix used for rotation of dimension q x q

γ = unknown vector for parallel translation of dimension q x 1

c - unknown scalar (constant) used for a central dilation

T, γ, and c, the unknowns, must be chosen such that the sum of squared errors (e_{ij}) associated with fitting matrix "A" to matrix "B" is minmized.

Generally, the main objective is to apply several transformations on "A" matrix in order to finally get:

$$B = \underset{\downarrow}{c}\underset{\downarrow}{A}T + J\ \underset{\downarrow}{\gamma'} + E \qquad (1)$$

unknowns

where: J' = row vector of (1,1,1,1,...,1) of dimension (p x 1) and

E = residual matrix of dimension (p x q)

Mathematically, the precise objective is to choose the parameters (T, γ, c) such that minimizing E'E (the sum squares of errors) and such that T' T = I.[3]

Since $E = (B - cAT - J\gamma')$ from (1) above,

then $E' = (B - cAT - J\gamma')'$

and $E'E = (B - cAT - J\gamma')'(B - cAT - J\gamma')$.

To obtain the solution for the unknown parameters of (1), one can differentiate the following objective function:

---

[3]This restriction has been imposed to assure the orthogonal transformation T T' - 1 = 0.

$$f = f_1 = f_2 \tag{2}$$

where: $f_1 = \text{tr } E'E = \text{constant} + c^2 \text{ tr } T'A'AT + p\ \gamma'\gamma = 2c\text{tr } B'AT - 2\text{tr}$
$B'J\ \gamma' + 2c \text{ tr } T'A'J\ \gamma'$ (3)

and: $f_2 = \text{tr } L(T'T - I)$ (4)

where L is a q x q matrix of unknown Lagrange multipliers, with respect to the unknowns T, γ, and c.

Therefore, the function of f will be minimized when:

$$\frac{\partial f}{\partial T} = 0 \tag{5}$$

$$\frac{\partial f}{\partial \gamma} = 0 \tag{6}$$

$$\frac{\partial f}{\partial c} = 0 \tag{7}$$

The solution of the partial derivatives in (5), and (6), and (7) will generate the least square estimates of the parameters T, γ, and c that minimize E'E as follows:

$$\frac{\partial f}{\partial T} = 2\ c2\ A'\ A\ T = 2cA'B + 2cA'J\gamma' = TM = \phi \tag{8}$$

where 0 is a (q x q) zero matrix and M = L + L' unknown symmetric matrix; and

$$\frac{\partial f}{\partial \gamma} = 2\ p\ \gamma - 2\ B'\ J + 2c\ T'A'J = \phi \tag{9}$$

and $$\frac{\partial f}{\partial c} = 2c \text{ tr } T'\ A'\ A\ T - 2 \text{ tr } B'AT + 2 \text{ tr } T'\ A'\ J\ \gamma' = \phi \tag{10}$$

From (9), one can obtain the value of γ as follows:

$$2\ p\ \gamma - 2\ B'\ J + 2c\ T'A'J = \phi$$

$$p\ \gamma = B'\ J = c\ T'A'J$$

$$\gamma\ B'\ J/p = c\ T'\ A'\ J/p$$

$$\gamma = (B' - cT'A')\ J/p$$

$$\gamma = (B - cAT)'\ J/p \tag{11}$$

From (8), one can obtain the value of T as follows:

$$2\ c^2\ A'AT - 2c\ A'B + 2\ cA'J\ \gamma' + TM = \phi$$

$$2\ c^2\ A'AT - 2cA'B + 2\ cA'J\ \gamma' = -TM$$

Then, premultiply both sides with T' to get

$$2\ c^2\ T'A'AT - 2c\ T'A'B + 2c\ T'A'J\ \gamma' = -\ M$$

$$2\ c(cT'A'AT - T'A'B + T'A'J\ \gamma') = -M$$

$$-\ cT'A'AT + T'A'B - T'A'J\ \gamma' = M/2c$$

$$T'A'B - T'A'J\ \gamma' = M/2c + cT'A'AT$$

and since T'A'AT is a symmetric matrix, one can write:

$$T'A'B - T'A'J'\gamma' = \text{Symmetric Matrix as well.}$$

Using Equation (11), one can substitute the value of γ' in the last equation, so:

$$T'A'B' - [T'A'JJ'/p]\ (B - cAT) = \text{Symmetric Matrix}$$

which in turn can be rewritten as:

$$T'A'B - [T'A'JJ'/p]B + [T'A'JJ'/p]cAT = \text{Symmetric Matrix}$$

$$T'A'(I - JJ'/p)B + [T'A'JJ'/p]cAT = \text{Symmetric Matrix}$$

Since the last term on the left side of the previous equation [(T'A'JJ'/p)cAT] is symmetric, that means:

$$T'A'(I - J'J/p)B = \text{Symmetric matrix as well.} \qquad (12)$$

Note that (12) is free from γ and c and can be solved for T at once by use of the same symmetry argument developed by Schonemann (1966).

Assuming that A'(I - JJ'/p)B = G, then (12) can be written in the form:

$$T'G = G'T \qquad (13)$$

Assuming that T matrix can be decomposed into two orthogonal matrices V and W', one can write:

$$T = V\ W' \text{ such that } V\ V' \text{ and } I \text{ and } W\ W' = I$$

If one takes the components of T (i.e., V & W' matrices) and creates with them on an assumed (new) non-negative diagonal matrix (D), the result would be the matrix G, that means:

$$V\ D\ W' = A'(I - JJ'/p)\ B = G \tag{14}$$

Then:

$$V\ D\ W' = G \tag{15}$$

is the Eckart-Young decomposition of the matrix $G = A'(I - JJ'/p)\ B$, a matrix which is proportional to the (sample) covariance matrix of (the columns of) A with B.

From (13), (14), and (15), one can notice that:

since $V\ D\ W' = G$

and $T'G$ = Symmetric Matrix

then $D = V'\ G\ W$

and $D = V'\ A'\ (I - JJ'/p)\ B\ W.$

Since $BDW' = G$ and since V and W' are two orthogonal matrices (the computer program used will generate the value of V and W'), then T can be computed since $T = V\ W'$.

Having computed T one can use it to solve (10) for the contraction factor c after eliminating γ by means of (11).

From (10), $2c\ \mathrm{tr}\ T'A'AT - 2\ \mathrm{tr}\ B'AT + 2\mathrm{tr}\ T'A'J\ \gamma$

$$c\ \mathrm{tr}\ T'A'AT - \mathrm{tr}\ B'AT + \mathrm{tr}\ T'A'JJ/p\ (B - cAT) = 0$$

$$c\ \mathrm{tr}\ T'A'AT - \mathrm{tr}\ B'AT + \mathrm{tr}\ T'A'JJ/pB - cAT\ \mathrm{tr}\ T'A'JJ'/p = 0$$

$$c\ (\mathrm{tr}\ T'A'AAT - \mathrm{tr}\ T'A'JJ'/p\ AT) = \mathrm{tr}\ B'AT - \mathrm{tr}\ [(T'A'JJ'/p)B]$$

That is,

$$c = \frac{\mathrm{tr}\ B'AT - \mathrm{tr}[(T'A'JJ'/p)B]}{\mathrm{tr}\ T'A'AT - \mathrm{tr}\ [(T'A'JJ'/p)AT]}$$

$$c = \frac{\mathrm{tr}\ T'A'(I - JJ'/p)B}{\mathrm{tr}\ A'\ (I - JJ'/p)A} \tag{16}$$

It might be noticed that there is no need to compute the translator vector γ explicitly, since:

$$\hat{B} = \hat{c}\hat{A}T + J\hat{\gamma} = \hat{c}\hat{A}T + (JJ'/p)\ (B - \hat{c}\hat{A}T)$$

$$= \hat{c}\hat{A}T + JJ'/pB - JJ'/p\ \hat{c}\hat{A}T$$

$$= (JJ'/p)\ B + \hat{c}\hat{A}T - JJ'/p\ \hat{c}\hat{A}T$$

$$\hat{B} = (J'J/p)\ B + \hat{c}(I - JJ'/p)\ \hat{A}T$$

Then, the matrix of residuals of the best fit would be:

$$E = B - \hat{B} = B - cAT - JJ'/p\ (B - cAT)$$

$$= B - cAT - JJ'/pB + jj'/p\ cAT$$

$$= B - JJ'/pB + jj'/p\ cAT - cAT$$

$$= (I - JJ'/p)\ B + (jj'/p - I)\ cAT$$

$$= (I - JJ'/p)\ B - (I - JJ'/p)\ cAT$$

$$E = (I - JJ'/p)\ (B - cAT)$$

It might be noticed that the matrix of residuals does not involve γ. In other words, the fit is the same regardless of the relative location of the origin of both the replacement-cost matrix "A" and the historical-cost matrix "B."

For the proposed study, the residual matrix will be computed by subtracting the RC factor loading matrix (i.e., the problem space "A" after doing all the above transformations on matrix "A to get matrix "$\hat{B}$") from the HC factor loading matrix (i.e., the target space "B"). The column that will show the sum of squares of each variable will provide an objective indication of the impact of RC adjustments on the individual ratios.

APPENDIX C

PROPERTIES OF SAMPLE FIRMS

TABLE X

FIRMS IN THE SAMPLE AND THEIR SYSTEMATIC RISK (USING EQUALLY WEIGHTED MARKET INDEX)

CRSP Company Number	Name	Period I Nov. 1, 1977 to Dec. 29, 1978 (14 Months)	Period II Jan. 3, 1978 to Dec. 29, 1978 (12 Months)	Period III March 1, 1978 to Dec. 29, 1978 (10 Months)
111 853 10	Brockway Glass Inc.	0.573	0.588	0.610
124 187 10	Buttes Gas & Oil Co.	1.675	1.594	1.610
148 429 10	Castle & Cooke Inc.	0.591	0.567	0.559
165 339 10	Chesebrough-Pond's Inc.	0.731	0.681	0.679
186 108 10	Cleveland Electric Illuminating Co.	0.365	0.359	0.324
191 162 10	The Coca-Cola Bottling Inc. of New York	0.934	0.980	0.956
200 273 10	Combustion Engineering Inc.	0.818	0.691	0.686
206 813 10	Cone Mills Corp	1.008	0.979	0.941
231 021 10	Cummins Engine Co. Inc.	0.868	0.866	0.840
235 773 10	Dan River Inc.	1.275	1.331	1.323
258 435 10	The Dorsey Corp. & Subsidaries	1.054	0.979	0.871
283 362 10	The Elpaso Co.	0.776	0.735	0.716
294 497 10	Equitable Gas Co.	0.234	0.214	0.214
294 497 10	Ferro Corp.	1.009	0.935	0.963
315 405 10	Foxbord Co.	0.684	0.662	0.582
351 604 10	Fugna Industrial Inc.	1.665	1.727	1.729
370 442 10	General Motors Corp.	0.583	0.553	0.517

TABLE X (Continued)

CRSP Company Number	Name	Period I Nov. 1, 1977 to Dec. 29, 1978 (14 Months)	Period II Jan. 3, 1978 to Dec. 29, 1978 (12 Months)	Period III March 1, 1978 to Dec. 29, 1978 (10 Months)
382 388 10	The B. F. Goodrich Co.	0.511	0.396	0.361
387 478 10	Graniteville Co.	0.570	0.584	0.615
398 028 10	The Greyhound Corp.	0.648	0.617	0.617
402 496 10	Gulf Resources & Chemical Corp.	1.320	1.393	1.351
452 308 10	Illinois Tool Works Inc.	0.925	0.909	0.906
455 434 10	Indianapolis Power & Light Co.	0.304	0.316	0.280
462 416 10	Iowa Electric Light & Power Co.	0.249	0.235	0.223
478 124 10	Johns-Manville Corp.	0.744	0.698	0.636
491 674 10	Kentucky Utilities Co.	0.296	0.277	0.259
595 390 10	Mid-Continent Telephone Corp.	0.378	0.360	0.344
611 662 10	Monsanto Co.	0.845	0.819	0.757
626 717 10	Murphy Oil Corp.	1.260	1.219	1.185
629 853 10	Nalco Chemical Co.	0.492	0.448	0.466
664 397 10	Northeast Utilities	0.090	0.085	0.075
709 317 10	Pennwalt Corp.	0.836	0.851	0.787
718 009 10	Philadelphia Suburban Corp.	0.865	0.843	0.816
731 095 10	Polaroid Corp.	1.298	1.286	1.253
737 628 10	Potlatch Corp.	0.816	0.740	0.659
770 553 10	H. H. Roberston Co.	0.968	0.958	0.923
775 371 10	Rohm & Haas Co.	0.830	0.817	0.767
781 088 10	Rubbermaid Inc.	1.006	1.047	1.060
826 418 10	Sierra Pacific Power Co.	0.311	0.295	0.252
837 004 10	South Carolina Electric & Gas Co.	0.344	0.310	0.263

TABLE X (Continued)

CRSP Company Number	Name	Period I Nov. 1, 1977 to Dec. 29, 1978 (14 Months)	Period II Jan. 3, 1978 to Dec. 29, 1978 (12 Months)	Period III March 1, 1978 to Dec. 29, 1978 (10 Months)
841 297 10	Southdown Inc.	1.030	1.062	1.079
853 683 10	Standard Oil Co. of California	0.776	0.792	0.747
884 102 10	Thiokol Corp.	1.286	1.229	1.184
902 182 10	Tyler Corp.	1.021	1.024	1.023
905 581 10	Union Carbide Corp.	0.642	0.613	0.608
938 837 10	Washington Gas Light Co.	0.298	0.334	0.296
940 688 10	The Washington Water Power Co.	0.262	0.231	0.223
962 898 20	Wheelabrator-Frye Inc.	0.974	0.949	0.924
976 826 10	Wisconsin Power & Light Co.	0.292	0.276	0.290
978 165 10	Wometco Enterprises Inc.	1.113	1.110	1.117

2

VITA

Fouad M. El-Leithy

Candidate for the Degree of

Doctor of Philosophy

Thesis: ON THE ASSOCIATION BETWEEN FINANCIAL RATIOS AND SYSTEMATIC RISK UNDER ALTERNATIVE REPLACEMENT COST MODELS

Major Field: Business Administration

Biographical:

Personal Data: Born in Cairo, Egypt, September 9, 1942, the son of Mohamed El-Leithy.

Education: Graduated from Port-Said High School, Port-Said, Egypt, in 1959; received the Bachelor degree from Helwan University, Port-Said, Egypt, in June 1963; received Master of Science degree in Accounting from Oklahoma State University, Stillwater, in July 1978; completed the requirements for the Doctor of Philosophy degree with major concentration in Accounting at Oklahoma State University in May, 1982.

Professional Experience: Internal auditor at El-Naser Textiles Company (Portex) at Port-Said, Egypt during Summer and Winter of 1963; graduate assistant, Accounting Department, College of Commercial and Administrative Sciences, Helwan University, Port-Said, Egypt, 1964-68; Assistant Controller at Al-Ghuraire Companies, Dubai, Arab Gulf 1969-1971; Assistant Controller at Bank of Oman, Dubai, Arab Gulf, 1971-72; Chief of Cost-Accounting and Inventory Management Department at Wockhardt Pharmaceutical Company, Bombay, India, 1972-73; Assistant Lecturer at the Accounting Department, College of Commercial and Administrative Sciences, Suez-Canal University, Port-Said, Egypt, 1973-76.