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THE INFORMATION CONTENT OF THREE PENSION COST MEASURES:
THEORETICAL AND EMPIRICAL ANALYSIS

The Ohio State University

Ph.D. 1981

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THE INFORMATION CONTENT OF THREE PENSION COST MEASURES: 
THEORETICAL AND EMPIRICAL ANALYSIS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for 
the Degree Doctor of Philosophy in the Graduate 
School of The Ohio State University 

By 
Rodger Gene Holland, A.S., B.S., M.A.

* * * * *

The Ohio State University
1981

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This dissertation is dedicated to my loving wife Melinda.
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Chapter I

INTRODUCTION

The problems of accounting for the cost of pension benefits have been of concern to the accounting profession for many years. In the mid-40s the rule-making body of the accounting profession (the Committee on Accounting Procedure) began studying pension cost accounting; it issued Accounting Research Bulletin 36 in 1948. Each subsequent decade, pension cost accounting has been reexamined by the rule-making body of the accounting profession. In 1956, the Committee on Accounting Procedure issued Accounting Research Bulletin 47, which specifically recognized past or prior service costs\(^1\) and gave accounting significance to vested

\(^1\) For those not familiar with pension cost accounting, Accounting Research Study No. 8 provides an excellent reference. An appendix to Accounting Research Study No. 9 provides definitions of pension terms not defined here.

Annual pension cost is the normal cost relating to provisions for the current year's service and amortization of the unfunded past or prior service cost.

Unfunded past or prior service cost---is the unfunded portion of both the past service cost and prior service cost. Past service cost is the cost assigned, under the actuarial cost method, to years prior to the inception of a pension plan. Prior service cost is the cost assigned, under the actuarial cost method, to years prior to the date of a particular actuarial valuation. Prior service cost includes any remaining past service cost. Unfunded vested benefits are those benefits which have not been funded and for which no future service is required by the employee.
benefits. In 1966, the Accounting Principles Board (APB) established the current Generally Accepted Accounting Principles (GAAP) for measuring pension costs in Opinion No. 8 (APB 8). In the mid-1970s, the Financial Accounting Standards Board (FASB) began considering pension cost accounting. The FASB split pension cost accounting into two separate but related issues: (1) accounting and reporting by a pension plan; and (2) accounting for the cost of a pension plan by the employer.\(^2\) Concerning the second issue, the subject of this study,\(^3\) the FASB has issued (1) an Interpretation\(^4\) which states that GAAP were not substantially modified by the Employee Retirement Income Security Act of 1974 (ERISA)\(^5\) and (2) a Statement of Financial Accounting Standards (FASB 36), "Disclosure of Pension Information." FASB 36 modifies the disclosure requirement of APB 8.\(^6\) The issue of calculating the cost of

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\(^2\) For convenience, the singular form will be used when dealing with a corporation's pension plan but a corporation may have several plans in actuality.

\(^3\) The analysis is further restricted to defined benefit plans.

\(^4\) Interpretation 3; Accounting for the Cost of Pension Plans Subject to the Employee Retirement Income Security Act of 1974: An Interpretation of APB Opinion No. 8.

\(^5\) Appendix A contains a summary of the effects of ERISA on pension plans, employees, and employers.

\(^6\) FASB 36 only slightly modified APB 8 in requiring additional disclosures about pension costs (particularly the "supplemental present values") and the interest rate assumption used for actuarial purposes. Most notably, though, when the figures are not readily available a company may continue to follow the provisions of APB 8.
these benefits and the related "liabilities" are under consideration by the PASB, as are other pension cost accounting issues.

Several reasons necessitated the review of pension cost accounting by the FASB; these include rising pension benefits, the flexibility allowed under APB 8, the differences of opinion between actuaries and accountants over the importance of some pension cost measures, and the impact of ERISA on fundamental assumptions. Concerning rising pension costs and benefits, median annual pension cost has increased from about 14% of income before taxes and depreciation in 1973 to about 19% in 1979. Data for earlier years are not readily available, but figures for selected firms indicate that the rise has been fairly steady since 1969. Other median pension cost measures have also risen.

APB 8 allows flexibility in several areas of pension cost accounting partly because the APB itself felt that "accounting for pension costs is in a transitional stage." Two important areas of flexibility relate to the existence of several acceptable actuarial cost methods and the treatment of unfunded past or prior service cost. Actuarial cost methods differ substantially in the level of costs they produce and with regard to their treatment of unfunded past

7 APB 8, par. 17.
or prior service cost (and unfunded vested benefits); some actuarial cost methods do not even separately compute these unfunded costs. Ross Skinner states that "... it is somewhat disconcerting to find that the unfunded actuarial liability has perhaps doubled over a period of the last two or three years ... and then to find that if this 'liability' were calculated by a different actuarial cost method the figure would be drastically reduced and if yet another method were used it would vanish entirely." This concern over differences in the magnitude of the measures caused by differences in actuarial cost methods rather than economic circumstances has grown in recent years and serves as a key reason for reviewing pension cost accounting.

A related flexibility issue is whether unfunded past or prior service cost should or should not be amortized against net income. Some authors argue that it should be amortized over the life of the employee group whereas other authors argue that for a going concern, an annual provision consisting of the normal cost and interest on the unfunded past or prior service cost will be adequate. With this view, this cost would never be charged to income; only the interest on it would be charged. APB 8 recognized both views by allowing a range where at the minimum, only interest on the unfunded past or prior service cost must be amortized against net income.

---

recognized; and at the maximum, the unfunded past or prior service cost may be amortized over 10 years. Since ERISA requires corporations to fund the unfunded past or prior service cost within 30 years (40 years for plans in existence as of January 1, 1974) the interest-only arguments may be questionable. These funding requirements also cast considerable doubt on the argument (reflected in APP B) that unfunded past or prior service cost is not a liability. Furthermore, ERISA makes corporations liable, in some circumstances, for unfunded vested benefits up to 30% of "net worth." For this reason, ERISA necessitates review of the basic assumptions regarding the non-recording of unfunded past or prior service cost as a liability. Even so, (most) actuaries still argue that these unfunded costs are not liabilities but are supplemental present values.

According to the actuaries, these amounts will become

---

9 Clare (1978) has pointed out that under ERISA net worth is defined by the Pension Benefit Guaranty Corporation and is not the same as stockholders equity which is defined by GAAP. The definition used by the Pension Benefit Guaranty Corporation relies on the market value of equity in the period prior to pension plan termination.

10 Under the going concern assumption, the concept of unfunded past or prior service cost suggests that unfunded past or prior service cost is a liability in an economic sense. However, the measurement of this economic liability is highly judgmental and is influenced by a multitude of factors (such as the actuarial cost method used). As yet, unfunded past or prior service cost is not shown on the balance sheet as a liability but as noted shortly, the FASB is considering whether or not unfunded past or prior service cost (or some other measure) should be included on the balance sheet.

11 See, for example, Paul and Fluhr (1977).
liabilities only if the pension plan terminates and the amount may differ from that reported as unfunded vested benefits. Skinner's views on unfunded vested benefits seem to reflect fairly the views of most actuaries. Other accountants feel that the unfunded vested portions are the only important measures. The FASB is currently considering, among other pension accounting issues, whether or not these supplemental present values should be recorded as liabilities of the corporation; and, if so, how they should be presented in the employer's financial statements.

The importance of studying these variables can be argued from several perspectives. The study may be regarded as important because: (1) the 40-year-old issue has never been resolved; (2) the importance (or lack of importance) of the pension cost measures is argued in an extensive business literature; (3) pension cost measures are viewed differently by many actuaries and accountants; (4) theoretical models could be developed to suggest how the measures should affect market returns; and (5) the relative magnitude of pension cost measures is large.

Since a FASB Task Force is reviewing pension cost accounting, a separate review would be of only marginal value. A review of the literature in (2) and (3) might

---

12 FASB 35, paragraph 140.
clarify the issues involved but would add little more than another opinion. The fourth approach could provide a better understanding of the relationships between the measures and expected market returns. The last approach suggests the possibility of empirically testing the importance of these measures. These last two approaches seem more useful and provide the basis for this research. The following chapter develops a theoretical model which is useful for examining the expected impact of pension costs on expected market returns (more precisely, systematic risk). It considers annual pension cost to be variable in nature and it treats unfunded past or prior service cost (and/or unfunded vested benefits) as future obligations where at least interest must be paid.

The theoretical model (and the above arguments) indicate that the treatment (by the market) of the unfunded vested benefits measure and the unfunded past or prior service cost measure should be consistent with treating the measures as economic liabilities of the firm even though, under GAAP, they are not required to be recorded as liabilities. The theoretical analysis in chapter three also demonstrates that

13 The term systematic risk is used when discussing the theoretical model because it is a concept where the market return is not empirically observable. One of several possible indices may be used as a surrogate for the market return which yields an empirical estimate of systematic risk; this empirical estimate is called beta. The term beta is used when discussing the empirical results.
these two measures should be treated as economic liabilities of the firm even if only interest is paid on the unfunded past or prior service cost. [Since unfunded vested benefits is a component of unfunded past or prior service cost, it should have the same directional effect.]

The second part of this study examines the importance of these three pension cost measures empirically where importance is defined in terms of information content (differences in beta). Even though ERISA may not have directly affected the magnitude(s) of the supplemental present values, it may have affected the importance of the values. Chapter four presents the methodology for studying the impact of ERISA on the perceived importance of the pension cost measures and presents the general methodology for studying the pension cost measures in the post-ERISA period. The methodology is quite similar to that used by Beaver, Christie, and Griffin [1980] and Collins and Simonds [1979]. In brief, the three values are standardized by forming ratios (e.g., annual pension cost/income) which are used to filter the firms into categories. Firms within each category are matched by industry and size to firms in other

14 A simple example is the unfunded past or prior service cost measure. Since ERISA imposed funding requirements which made it necessary to fund unfunded past or prior service cost (prior law did not require it to be funded), ERISA may have changed the nature and meaning of the unfunded past or prior service cost measure. If the nature and meaning was changed, it may have also changed the information content of the measure.
categories to form matched portfolios. These portfolios are used in analysis of covariance (ANCOVA) tests.

The empirical analysis in chapter five demonstrates that the market's reaction to the unfunded vested benefits measure was consistent with the hypothesis that it was an economic liability in the pre-ERISA period but not consistent with this hypothesis in the post-ERISA period.15 However, the unfunded past or prior service cost measure, on the other hand, did not have an association with beta in the pre-ERISA period. In the post-ERISA period, the market's reaction appears to be opposite what would be expected if the unfunded past or prior service cost measure was considered an economic liability: namely, that there is a negative correlation between the unfunded past or prior service cost and beta. This reaction may be caused by the existence of pension insurance from the Pension Benefit Guaranty Corporation. Although explained more fully in chapter five, the basic rationale is that those firms with relatively large amounts of unfunded past or prior service cost transfer the risk for a larger portion of their total pension obligation to the PBCG than those firms with relatively small amounts of unfunded past or prior service cost. This could counter the effect of treating unfunded

15 Both theoretical and empirical analysis have previously shown that an economic liability should have a positive association with systematic risk (beta).
past or prior service cost as an economic liability.

The empirical analysis also examines the association between annual pension cost and beta and finds that in neither period was annual pension cost associated with beta. However, it was found that the firms which had the largest increase in annual pension cost when ERISA was enacted also had the largest increase in beta. This may indicate that those firms which increased their funding of the unfunded past or prior service cost above the minimum required by ERISA experienced an increase in beta.

As with any empirical study, these results are subject to certain limitations which are discussed in chapter six. Chapter six also summarizes the results and suggests possibilities for further research related to this study.
Chapter II

THEORETICAL MODEL: EXPECTED RELATIONSHIPS OF PENSION COST MEASURES TO SYSTEMATIC RISK

The objective of this chapter is to establish the theoretical relationship between systematic risk and pension cost measures which will provide a better understanding of the expected effects of the pension cost measures on systematic risk; later chapters examine this relationship empirically by using beta as an estimate of systematic risk.

The capital asset pricing model (CAPM)\(^1\) serves as the starting point for this analysis; it is supplemented by Hite [1977] in formulating the value of equity. The return measure used in the definition of systematic risk is expanded to include net income, unfunded pension costs, and the value of equity. The constants are factored out (or eliminated) from the covariance term, and Hite's definition of the value of equity is incorporated. Rearranging the terms results in a model which is used to show that all three pension cost measures should have a positive relationship with systematic risk. The CAPM is expressed as follows:

\[ R_i = R_f + \beta_i (R_m - R_f) \]

\(^1\) The assumptions underlying the CAPM are given in Appendix B for the interested reader.
\[ E(\hat{R}_{jt}) = R_f + \hat{\beta}_j [E(\hat{R}_{mt}) - R_f] \]

\[ \hat{\beta}_j = \frac{\text{cov}(\hat{R}_{jt}, \hat{R}_{mt})}{\sigma^2 \hat{R}_{mt}} \]

where:

- \( R_{jt} \) = return to security \( j \) in time period \( t \)
- \( R_{mt} \) = return to the market in time period \( t \)
- \( R_f \) = risk free rate
- \( t \) = time period
- \( j \) = firm
- \( \text{cov} \) = covariance operator
- \( \sigma^2 \) = variance operator
- \( \hat{\varepsilon} \) = random variable

\( E(\hat{R}_{mt}) - R_f \) is often called a risk premium.

Note: For expositional convenience the subscripts will be dropped from the equations unless two securities are being contrasted. To help keep the return to security \( j \) separate from other returns, \( \hat{R}_{mt} \) will denote the market return and \( R_f \) will denote the risk free rate.

The return to a security can also be expressed in dollar amounts. Following Rubinstein [1973b], the dollars available to equity are divided by the value of equity.

\[ \hat{R} = \frac{\hat{X} - rD^0}{S^0} \]

where:

- \( \hat{X} \) = dollar value of net operating income before interest for firm \( j \) in period \( t \)
- \( r \) = rate of interest on debt
- \( D^0 \) = present dollar value of debt for firm \( j \) at the beginning of period \( t \)
- \( S^0 \) = present dollar value of equity for firm \( j \) at the beginning of period \( t \)
- \( o \) = beginning of the period
Net operating income before interest can be expressed as a function of quantity, price, variable costs, fixed costs, and, for our purposes, pension costs. The functional form is given in Hamada [1972] but is expanded here to include pension costs.\(^2\)

\[
\gamma = Qp - Qvc - F - \gamma B^0
\]  

(4)

where:

- \(Q\) = quantity of output sold by firm \(j\) in period \(t\)
- \(p\) = price of output for firm \(j\) in period \(t\)
- \(vc\) = variable cost of output for firm \(j\) in period \(t\)
- \(F\) = fixed cost of output for firm \(j\) in period \(t\)
- \(B^0\) = unfunded past or prior service costs (UPS) for firm \(j\) at the beginning of period \(t\)
- \(\gamma\) = portion of \(B^0\) firm \(j\) funds in period \(t\)

Substituting Equation 4 into 3, and 3 into 2 yields the following:

\[
\beta = \frac{\text{cov}[\gamma - (Qp - Qvc - F - \gamma B^0 - \gamma D^0), R_m]}{\sigma^2 R_m}
\]  

(5)

This equation expresses systematic risk in terms of earned income but still does not lend itself to easy interpretation regarding pension costs. To simplify the equation, some covariance properties will be used. Since

\(^2\) Appendix C gives a more detailed development of the form of the functional relationship based on accounting concepts.
mean shifts do not affect the covariance term [i.e.,
\( \text{cov}(x+k, y) = \text{cov}(x, y) \)], Equation 6 immediately follows:

\[
\beta = \frac{\hat{\delta}p - \hat{\delta}vc}{S^0 \sigma^2 Rm}
\]

(6)

Known also is that \( \text{cov}(ax, y) = acov(x, y) \). Using this, the
\((p - vc)\) and \(S^0\) terms can be factored outside of the
covariance which yields:

\[
\beta = \frac{p - vc}{S^0} \ast \frac{\text{cov}(\hat{\gamma}, Rm)}{\sigma^2 Rm}
\]

(7)

This expression is simpler than Equation 5 but is incomplete
because it does not consider the relationship of earnings to
the value of equity. Hite [1977] has developed such an
expression for the value of equity which is used here.

\[
S^0 = \frac{E(\hat{x} - rD^0) - \lambda \text{cov}[(\hat{x} - rD^0), \hat{\gamma}]}{1 + Rf}
\]

(8)

where:

\[
\lambda = \text{market 'price of risk' in dollars}
\]

\[
\lambda = \frac{E(Rm) - Rf}{\sigma^2 Rm}
\]
Using the covariance analysis from above and substituting Equation 8 into Equation 7 yields:

\[
\beta = \frac{(p-vc) (1+R_f)}{E(Q) - \lambda \text{cov}(\dot{Q}, R_m) - \frac{\text{cov}(\dot{Q}, R_m)}{(p-vc)}} \frac{\text{cov}(\dot{Q}, R_m)}{\sigma^2 R_m}
\]

or after dividing numerator and denominator by \((p-vc)\):

\[
\beta = \frac{1+R_f}{\frac{E(Q) - \lambda \text{cov}(\dot{Q}, R_m) - \frac{\text{cov}(\dot{Q}, R_m)}{(p-vc)}}{\sigma^2 R_m}} \frac{\text{cov}(\dot{Q}, R_m)}{\sigma^2 R_m}
\]

Now assume that "normal" annual pension cost is a component of variable cost. Under ceteris paribus assumptions, variable cost and systematic risk should have a positive causal relationship, i.e., if variable cost goes up, systematic risk should go up and if variable cost goes down, systematic risk should go down.

---

3 Annual pension cost is often directly related to labor cost, which is nearly always considered variable. As will be shown shortly, whether the cost is variable or fixed is irrelevant since both have the same impact on systematic risk.
Similarly, fixed costs, the amount of debt, and unfunded pension costs should have positive causal relationships with systematic risk.⁴ [To see this, start with the second line of the analysis for variable cost.] The distinction between variable cost and fixed cost loses significance for our purposes since both have the same directional impact on systematic risk.

The above analysis is consistent with Rubinstein [1973b] and Hamada [1972]. The rest of this chapter is devoted to demonstrating the consistency of this analysis with the analysis by Rubinstein and Hamada.⁵ Rubinstein derives the

---

⁴ Though it is not the primary purpose of this chapter, the model can also be used to show how size and industry factors can influence systematic risk. These are two facts which have been long known but have not been adequately modeled. These extensions are briefly discussed in Appendix D.

⁵ The model is inconsistent with Lev [1974]. One difference
followinng equation:

\[ \rho (\hat{R}^+, \hat{R}_m) \sigma_{\hat{R}^+} = \Sigma_k [\alpha_k (p_k - vc_k) \rho (\hat{Q}_k, \hat{R}_m) \sigma (\hat{Q}_k / \alpha_k \hat{V}_0)] \]  

(11)

where:

- \( \alpha_k \) = proportion of assets devoted to production in segment \( k \) for firm \( j \) in period \( t \)
- \( \hat{V}_0 \) = \( \hat{D}_0 + \hat{S}_0 \)
- \( + \) = no debt
- \( k \) = segment of firm \( j \) in period \( t \)
- \( \rho \) = correlation coefficient

Note: As before, the \( j \) and \( t \) subscripts are omitted.

To demonstrate that Rubinstein's equation is consistent with the model developed here, it will be simplified and shown to be similar to Equation 7 above. First, to simplify the analysis, assume one segment (or sum over \( k \)) to obtain:

\[ \rho (\hat{R}^+, \hat{R}_m) \sigma_{\hat{R}^+} = (p - vc) \rho (\hat{Q}, \hat{R}_m) \sigma (\hat{Q} / \hat{V}_0) \]  

(12)

Factoring the \( \hat{V}_0 \) term outside of \( \sigma (\hat{Q} / \hat{V}_0) \) yields:

\[ \rho (\hat{R}^+, \hat{R}_m) \sigma_{\hat{R}^+} = \frac{p - vc}{\hat{V}_0} \rho (\hat{Q}, \hat{R}_m) \sigma \hat{Q} \]  

(13)

Multiplying both sides by \( 1 / \sigma_{\hat{R}_m} \) yields:

\[ \rho (\hat{R}^+, \hat{R}_m) \times \frac{\sigma_{\hat{R}^+}}{\sigma_{\hat{R}_m}} = \frac{p - vc}{\hat{V}_0} \rho (\hat{Q}, \hat{R}_m) \times \frac{\sigma_{\hat{Q}}}{\sigma_{\hat{R}_m}} \]  

(14)

between the model developed here and Lev's model is that he implicitly assumes that differences in variable cost will not result in differences in stock prices whereas that assumption is not used here.
Expanding the correlation coefficient on both sides yields:

\[
\begin{align*}
\text{cov}(\hat{R}^+, \hat{R}_m) \cdot \frac{\sigma_{R^+}}{\sigma_{R^+}} \cdot \frac{\sigma_{R_m}}{\sigma_{R_m}} &= (\frac{p - vc}{\nu_0}) \cdot (\frac{\text{cov}(\hat{Q}, \hat{R}_m)}{\sigma_Q \cdot \sigma_{R_m}}) \cdot \frac{\sigma_{\nu}}{\sigma_{\nu}} \\
\end{align*}
\]

(15)

Simplifying and rearranging terms yields:

\[
\begin{align*}
\hat{\beta}^+ &= \frac{p - vc}{\nu_0} \cdot \frac{\text{cov}(\hat{Q}, \hat{R}_m)}{\sigma_{R_m}^2} \\
\end{align*}
\]

(16)

Since there is no debt, \(\nu_0 = S^0\) and an equation similar to Equation 7 is obtained:

\[
\begin{align*}
\beta^+ &= \frac{p - vc}{S^0} \cdot \frac{\text{cov}(\hat{Q}, \hat{R}_m)}{\sigma_{R_m}^2} \\
\end{align*}
\]

(17)

The only difference is that Rubinstein does not allow for debt and has \(\beta^+\) instead of \(\beta\). As Hite has shown, debt has an impact on \(S^0\) and enters the analysis through the denominator of the first term on the right hand side of Equation 17. The analysis is consistent with Rubinstein for all components: variable cost, fixed cost, debt, and pension cost.
Hamada uses mean variance analysis to develop a relationship between systematic risk and leverage. His final result is found in the following equation:

\[
\frac{s_0^+}{s_0} \beta = \left( \frac{\beta^+}{\beta} \right) \beta^+ (18)
\]

where terms are defined as above and \( + \) denotes no debt.

The important result though comes from his empirical analysis\(^6\) which found that \( \beta > \beta^+ \). This is consistent with the analysis performed above where it was indicated that debt has a positive causal relationship with systematic risk. Under the assumption that unfunded pension costs are liabilities, Hamada's results could be used to show that unfunded vested benefits (UVB) and unfunded past or prior service cost (UPS) have a positive relationship with systematic risk. The analysis used here assumes that the unfunded costs represent future commitments and are liabilities in that sense; further assumptions about whether or not they should be recorded as liabilities are not necessary. Furthermore, the analysis used here shows that even if only interest is paid on the unfunded costs, the costs still have an expected impact on systematic risk.

\(^6\) The empirical analysis uses beta (\( \beta \)) as an empirical estimate of systematic risk.
In summarizing, the analysis in this chapter has shown that all three pension cost measures have a positive causal relationship with systematic risk in a theoretical model based on the CAPM. This holds whether the pension cost is considered fixed or variable and even when only interest is charged on the unfunded portion of the benefits. The analysis has been shown to be consistent with both Rubinstein and Hamada.
Chapter III

INFORMATION CONTENT: A LITERATURE REVIEW AND DEFINITION

Ball and Brown [1968] helped change the nature of accounting research by introducing capital market research to accounting by examining the information content of accounting income numbers. Information content was inferred by examining abnormal returns; an abnormal performance index (API) was created to measure those abnormal returns. Specifically, the API at month $M$ was defined as:

---

1 Concerning the studies dealing with the information content of annual accounting numbers, Kaplan [1978] succinctly provided the reasons for this research as being "interested in seeing whether our methodologies are able to detect this relationship (between earnings and stock prices) and are able to establish the strength of the relationship. More important, we academic accountants exist in a skeptical world in which we have to prove such relationships to our colleagues, particularly when we attempt to assert the importance of accounting information." According to Kaplan, market research has confirmed that accounting manipulation to increase profits does not increase stock prices. Furthermore, accounting earnings have been found to have a high degree of association with market parameters. The research proposed here examines the association of three pension measures with market returns.
\[ \text{API} = \frac{1}{N} \sum_{j=1}^{N} \sum_{t=-11}^{M} (1 + \hat{\varepsilon}_{jt}) \]  

(19)

where:

- \( \hat{\varepsilon} \) = estimated variable or parameter
- \( M \) = some arbitrary time period (in months)
- \( N \) = the number of firms in the portfolio
- \( \hat{\varepsilon}_{jt} \) = the residual for firm \( j \) in month \( t \)

and \( \hat{\varepsilon}_{jt} \) is found from the market model and its expectation:

\[ \hat{R} = \alpha + \beta \hat{R_m} + \hat{\varepsilon} \]  

(20)

\[ E(\hat{R}) = \hat{\alpha} + \hat{\beta} E(\hat{R_m}) \]  

(21)

The assumption is often made that \( E(\hat{R}_m) = \hat{R}_m \) and the market model is expressed as follows:

\[ E(\hat{R}) = \hat{\alpha} + \hat{\beta} \hat{R_m} \]  

(22)

\[ \hat{\varepsilon} = \hat{R} - E(\hat{R}) \]  

(23)

The interpretation was that the "API traces out the value of one dollar invested (in equal amounts) in all securities \( j \) (\( j = 1, 2, ..., N \)) at the end of month \(-12\) (that is, 12 months prior to the month of the annual report) and held to the end of some arbitrary holding period \( (M = -11, -10, ..., T) \) after abstracting from market effects."\(^2\) The API, though, was not used directly to infer information content. In particular, Patell states the following (using different notation; p. 535):

\[^2\] Ball and Brown, p. 345.
Tests of information content examine the association between the random variable $K(\tilde{s})$ and events $y$ in the partition of the signal space $Y$. The null hypothesis of the test is statistical independence.

$$H_0 : F(K|y) = F(K) \text{ for all } y \in Y$$

(24)

Most API analyses have concentrated on the first moment of the density function and have drawn the inference that:

$$E(API) \neq 0 \Rightarrow F(K|y) \neq F(K)$$

(25)

[$F = the distribution function$]

This inference in Equation 25 has received criticism in recent years and the controversy over the usefulness of the API may not be settled for some time. Gonedes [1975] avoids this inference problem by concentrating on the return vector itself rather than the residuals. Specifically, $y$ has information content if:

$$F(K|y) \neq F(K) \text{ for some } y \in Y$$

(26)

or

$$F(K|y^1) \neq F(K|y^2) \text{ for some } (y^1, y^2) \in Y$$

(27)

$y^i = some realization of Y, y^1 \neq y^2$

The Gonedes definition relies on statistical independence directly$^3$ and does not require the inference

$^3$ An intuitive interpretation is that the variable $y$ (e.g., unfunded vested benefits) provides information about variable $K$ (e.g., expected mean returns). Thus if two firms differed only in the amount of unfunded vested benefits, knowing this difference would provide information about the expected difference in expected mean
needed in API analysis. The definition used here relies on statistical independence directly. In particular, the null hypothesis is:

\[ F(K|y^{11}, y^{21}, y^{31}, o) = F(K|y^{12}, y^{22}, y^{32}, o) \]  

(28)

where:

- \( F \) = the distribution function
- \( K \) = the variable (or parameter) under study
- \( y \) = realizations of the information variable \( i \) at level \( k \)
- \( Y \) = the set of all possible values for \( y \)
- \( o \) = set of other informational variables

Note: In some tests, \( y^{11} \) may be equal to \( y^{12} \), etc. In no cases will all three informational variables be the same.

As indicated earlier by Patell, most studies of information content in accounting have concentrated on the first moment (mean) of the return distribution. The returns are defined as:

returns.

* Beaver, Christie, & Griffin (1980) use a similar definition. They propose the following at the outset of their paper: \( F(K) \neq F(K|y) \) for some \( y \in Y \) as a definition of information content. However, their actual analysis uses the following null hypothesis:

\[ F(\tilde{y}|y^{11}, y^{21}, y^{31}) = F(\tilde{y}|y^{12}, y^{22}, y^{32}), y^{11}, y^{12}, \text{etc.} \]
\[ \hat{R} = \frac{(\hat{P}_t^j + \hat{a} - P_0^t)}{P_0^t} \]  

where:

- \( \hat{R} \) = return for firm \( j \) in month \( t \)
- \( P_t^j \) = price of stock for firm \( j \) at the end of period \( t \)
- \( P_0^j \) = price of stock for firm \( j \) at the beginning of period \( t \)
- \( d \) = dividends for firm \( j \) in period \( t \)
- \( \sim \) = a random variable

[This is the empirical analog of Equation 3.]

Other measures of interest also studied have been the variance of returns (total risk) and beta. Accountig studies have placed much more emphasis on beta than total risk and the theoretical model suggests there is reason to believe that beta (as an estimate of systematic risk) may differ among the levels of the informational variables.

This study uses a narrow definition of information content in that only beta is examined.\(^5\) Justification for this narrow definition follows four arguments. First, empirical evidence has found that the intercept term in the ordinary least squares regression of individual (or portfolio) returns on market returns\(^6\) is not statistically different from zero which leaves beta as a key determinant

\(^5\) Specifically, beta is the variable \( K \) in Equation 28 and no other variable is considered.

\(^6\) This regression is often referred to as the market model and is given above.
of differences in expected returns. Assuming the intercept term to be negligible, comparing two securities (or portfolios) over the same time period demonstrates that differences in expected returns are determined by differences in beta. Second, strict adherence to the definition of information content loses interpretability. For example, the economic significance of differences in (say) the fourth moment is not apparent. Third, many previous studies have used a narrow definition through examining only differences in mean returns (expected or actual). Last, beta is an important variable in its own right and is sufficiently interesting to examine.

---

7 Equation 29 indicates that differences in beta, based on differences in $y_{1k}$, are sufficient to lead to rejection of the null hypothesis of no information content. More importantly, though, such differences in beta imply differences in expected returns when the intercept term is negligible.

8 In fact no previous study (to the best of my knowledge) has used a test of equality of distributions as implied by equations 24, 26, and 27.

9 Arguments as the validity of beta as an interesting measure could follow several lines. Let it suffice to indicate that the measure has been the subject of several theoretical and empirical studies in recent years.
Chapter IV
METHODOLOGY

Three questions are addressed in this part of the research. The first and second questions are related; (1) do the measures have information content in the post-ERISA period and (2) was the information content changed by ERISA. The first question is important because unless the relationships between the measures and beta have changed since 1979 (the last year return data is available) a better understanding of the relationships in the current setting may be obtained. The second question addresses one of the possible impacts of ERISA.

ERISA imposed vesting and funding requirements on employers and established the Pension Benefit Guaranty Corporation. Even though the amounts of the pension cost measures may not have been affected by ERISA, the importance of the measures may have been. For example, prior to ERISA there was no legal requirement to fund the past or prior service cost which must be funded in 40 years or less under ERISA. Arguably, ERISA increased the informational value of UPS by changing the importance of it. The purpose of the second phase of the research is to test for such effects.
The answers to the last question add further insight concerning ERISA. Specifically, what was the effect of ERISA on the portfolios of firms which had the largest changes\(^1\) in the pension cost measures? For example, since ERISA imposed vesting requirements on employers, one set of portfolios to be contrasted is (a) a portfolio of firms which had zero amounts for UVB in both the pre-ERISA period and post-ERISA period to (b) a portfolio of firms which had zero UVB in the pre-ERISA period and non-zero UVB in the post-ERISA period. This contrast tests the joint effect of the imposition of the vesting requirement and the sudden recognition of non-zero UVB measures. The three phases are summarized by the following sets of hypotheses.

Phase One: Information Content in the Post-ERISA Period

\[ H_{0mp'} : \beta_{mcp'} = \beta_{mc'p'} \tag{30} \]

where:

- \( H_0 \) = null hypothesis
- \( m \) = measure under study
- \( c \) = classification;
  - \( c \) = small amounts of the measure,
  - \( c' \) = large amounts of the measure
- \( n \) = period;
  - \( p \) = pre-ERISA,
  - \( p' \) = post-ERISA

\(^1\) As explained later, "small" and "large" changes are determined relative to the median change.
The interpretation for this phase is simple: rejection of
30 implies information content of the measure, failure to
reject 30 implies lack of information content. These tests
indicate whether or not the measures had information content
for the period of September 1975 through December 1979.²

Phase Two: Changes in Information Content

\[ H_{0mp} : \beta_{mc} = \beta_{mc} \]  \hspace{1cm} (31a)
\[ H_{0mp}^* : \beta_{mc} = \beta_{mc} \]  \hspace{1cm} (31b)

where: terms are as defined above

Note: 31b is the same as 30

If neither 31a nor 31b is rejected the measure did not
possess information content in either the pre-ERISA period
or the post-ERISA period and therefore the information
content could not be impacted by ERISA. Rejection of 31b
but not 31a indicates that the measure has information
content in the post-ERISA period but did not have
information content in the pre-ERISA period. This implies
that ERISA increased (created) the information content of
the measure. Rejection of 31a but not 31b indicates that
the measure had information content in the pre-ERISA period

² FASB 36 requires different measures (from UVB and UPS) to
be reported after December 31, 1980 so extensions to the
current environment may not be appropriate. This suggests
an interesting comparison of the information content of
UVB and UPS to the measures required by FASB 36 which may
be pursued in a subsequent study.
but does not have information content in the post-ERISA period. This implies that ERISA decreased (eliminated) the information content of the measure. Rejection of both 31a and 31b requires further analysis where the differences in risk for each period must be examined.

Phase Three: Changes in Magnitude of Measures

\[ H_{omc} : \quad mcp = mcp' \]  \hspace{1cm} (32a)

\[ H_{omc'} : \quad mc'p' = mc'p' \]  \hspace{1cm} (32b)

where: terms are as defined before except for \( c \)
\( c \equiv \) classification;
\( c = \) small increase or a decrease,
\( c' = \) large increase

Rejection of 32a or 32b, but not both, indicates that the change in the measure is correlated with a change in risk and that the magnitude of the change in the measure allows the market to determine risk adjustments based on such change. The change in the measure had information content which implies the measure had information content and may have been affected by ERISA. Rejection of 32a and 32b requires further analysis to determine whether or not there was a difference in the change in the betas. For example, if one group's beta went up and the other's went down, information content is still implied. If both changed in

\[ \text{The past tense is used since the period over which the changes took place is 1973 to 1974. The information content may have changed since then.} \]
the same direction, the magnitude of the changes must be examined. Rejection of neither 32a or 32b implies a lack of information content in the changes in the measures.

Having summarized the tests to be conducted, the next sections examine the methodology used to conduct these tests. The methodology is explained in the order discussed above.

4.1 INFORMATION CONTENT IN THE POST-ERISA PERIOD

The primary purpose of the post-ERISA market analysis is to determine the information content of three pension cost measures; testing the empirical validity of the theoretical model proposed in chapter two is of secondary concern. Selecting the primary purpose is critical because it dictates whether two-tailed or one-tailed tests are used. Reviewing the definition of information content indicates an important point; simple inequality of the dependent variable (for different levels of the information variable) is sufficient to reject the null hypothesis of no information content. Conversely, in testing the theoretical model, a directional impact must be examined so that rejecting the null implies the direction of the impact. Rejecting the null in testing the model implies information content, but failing to reject the null (rejecting the model) does not imply lack of information content. Examining the hypotheses
for beta with regard to annual pension cost (APC) more fully illustrates this point.\footnote{In a statistical sense, the null hypothesis is always set up at a particular point (usually equality). Setting the null under $H_0$ in the manner in the text facilitates exposition for the benefit of those less statistically inclined.}

$$H_{0i} \quad \beta_j = \beta_k \quad \text{for } APC_j > APC_k \quad (33a)$$
$$H_{ai} \quad \beta_j \neq \beta_k \quad (33b)$$

$$H_{om} \quad \beta_j \leq \beta_k \quad \text{for } APC_j > APC_k \quad (34a)$$
$$H_{am} \quad \beta_j > \beta_k \quad (34b)$$

where:

- $H_0$ = null hypothesis
- $H_a$ = alternative hypothesis
- $i$ = information content (two-tailed) analysis
- $m$ = model verification (one-tailed) analysis

Clearly, if $\beta_j$ were statistically significantly less than $\beta_k$ then $34a$ would not be rejected whereas $33a$ would be rejected. If the model is inadequately specified and the impact is opposite that expected, one-tailed tests would allow rejection of the model but no statement could be made regarding information content. Conversely, if information content is concluded under the two-tailed test, then inferences can be made regarding the theoretical model because two-tailed tests are conservative in one-tailed inferences. That is, if $\beta_j > \beta_k$ and $33a$ is rejected, $34a$ would also be rejected, but if $\beta_j < \beta_k$ and $33a$ is rejected, $34a$ would not be rejected. In essence, the two-tailed tests
decrease the power of the tests on the model and if the model is well specified decrease the probability of concluding that there is information content. If the model is not well specified, two-tailed tests are essential to detect a relationship in the direction opposite from that expected and thus to detect information content. Consistent with the primary purpose, two-tailed tests are used in this analysis.

4.1.1 Specifying the Sample and Treatment Groups

As pointed out earlier, the three pension cost measures examined in this study are interrelated. Difficulties in separating the effects of these measures are compounded because some actuarial methods do not separately compute UPS and UVB.5 A firm may report zero values for UPS and UVB due to the actuarial method used rather than to the underlying circumstances or it may actually have zero values for UPS and UVB irrespective of the actuarial method(s) used. However, the number of "actuarially induced" zero-valued UPS and UVB firms probably greatly exceeds the number of "true" zero-valued firms. The analysis is therefore restricted to non-zero valued UPS firms. Further restrictions to the population of firms on COMPSTAT yields 617 firms which meet

5 The aggregate method is one actuarial method that does not separately compute these values. In collecting the data, it was observed that several firms use some method which does not separately compute these values.
the criteria.

Specifically, the sample consists of all firms which (1) reported all three measures for the post-ERISA period, (2) reported net sales, total assets, and total liabilities for the post-ERISA period, (3) had positive average net income before taxes and depreciation, and (4) has return data on the 1980 PDE tape. Having selected the sample, the firms were classified into meaningful categories based on the measures of interest. For this purpose, a filtering device somewhat similar to that in Beaver, Christie, and Griffin (RCG) [1980] is used.

4.1.2 Filtering Mechanism

The basic objective is to filter the firms into meaningful categories based on the pension cost measures (APC, UVB, and UPS). However, filtering by the measures directly is inappropriate because to do so would result in filtering by size as much (or more than) as by the measures. Those with large absolute measures primarily come from the larger firms and vice-versa. Some type of ratio is needed

---

* The post-ERISA period begins with September 1975 and ends with December 1979, the last month return data is available. September 1975 is used as a starting point because, as with most studies of this type, 12 months of data after the event date are eliminated to help reduce noise.

7 The positive net income restriction aids in the ratio analysis used below.
to eliminate the affects of size.

There is not a clearly apparent ratio to use. The ratios chosen were selected for their interpretative meaning. Net income (a flow measure) is used as a base for APC (a flow measure) to express APC as a percentage of net income. This relies on the assumption that the larger the components on net income, the more important they are. Total assets is used as a base for both UVB and UPS because these measures are of a long term nature and so is the asset base. Specifically, the following ratios are calculated and used to separate the firms into categories.

$$\text{Ratio1}_j = \frac{\sum_{k=1975}^{1978} \text{APC}_{jk}}{\sum_{k=1975}^{1978} \text{NI}_{jk}}$$

$$\text{Ratio2}_j = \frac{\sum_{k=1975}^{1978} \text{UVB}_{jk}}{\sum_{k=1975}^{1978} \text{TA}_{jk}}$$

* Other bases for all three measures were used and similar results were obtained.
\[
\text{Ratio}_{jk} = \frac{\sum_{k=1975}^{1978} \text{UPS}_{jk}}{\sum_{k=1975}^{1978} \text{TA}_{jk}}
\]

where:

- APC = annual pension cost
- UVB = unfunded vested benefits
- UPS = unfunded past or prior service cost
- NI = net income
- TA = total assets
- \( j \) = firm
- \( k \) = year

Note: Even though return data is complete through 1979, the COMPUSTAT data is complete only through 1978.

Previous researchers have used medians to partition firms at a single point in time. The filtering device used here should result in a more accurate classification regarding pension costs since temporary fluctuations are eliminated by the long term ratios. The following diagram may clarify this point.\(^9\)

\(^9\) In the discussion of Hamada (1972) Lintner makes the following points [p. 455]:

The estimates suggest that leverage accounts for up to about one fourth of the systematic risk [\( \text{beta} \)] of the stock of the sample, and perhaps still more significantly that long run average ratios provide more effective estimates of leverage on \( \text{beta} \) than do annual data.

The arguments in the text also hold.
Diagram 1
Classification Errors

<table>
<thead>
<tr>
<th>Ratio</th>
<th>A</th>
<th>B</th>
<th>A</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>critical value</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>B</td>
</tr>
</tbody>
</table>

In Diagram 1, if 1976 were used as the filtering point, firm A would be classified as low and B as high by previous filtering devices. In most cases, pension costs are evaluated in terms of their long run impact and temporary fluctuations should not result in classifications different from their long run position. The long run filter used here is therefore more accurate than a short run filter.

The critical ratios are used to sort the firms into 8 categories. For a firm to be classified as (low, low, low) [(0, 0, 0)], all three ratios must be below the median, etc. Results of applying this mechanism are shown in Table 1.

---

10 A filtering mechanism does not fully utilize the information in the ratios because the firms are treated as being the same within each classification. For example, a firm with a ratio that is 5% above the median is treated the same as one which is 45% above the median when there may be a difference between the two. However, by grouping the firms a more precise estimate of beta is possible and this increased precision may offset the loss in information. [As will be noted later when discussing the results, this increased precision does offset the loss in information.]
Table 1
Filter Results for Three Variables

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Number of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1 000</td>
<td>n&lt;1&gt; (208)</td>
</tr>
<tr>
<td>G2 001</td>
<td>n&lt;2&gt; (24)</td>
</tr>
<tr>
<td>G3 010</td>
<td>n&lt;3&gt; (35)</td>
</tr>
<tr>
<td>G4 011</td>
<td>n&lt;4&gt; (42)</td>
</tr>
<tr>
<td>G5 111</td>
<td>n&lt;5&gt; (212)</td>
</tr>
<tr>
<td>G6 110</td>
<td>n&lt;6&gt; (20)</td>
</tr>
<tr>
<td>G7 101</td>
<td>n&lt;7&gt; (31)</td>
</tr>
<tr>
<td>G8 100</td>
<td>n&lt;8&gt; (45)</td>
</tr>
</tbody>
</table>

0 = low (below the median)
1 = high (above the median)
APC is represented in column one.
UVB is represented in column two.
UPS is represented in column three.

The small number of firms in some of the portfolios makes it impossible to match by industry, sales, total assets, and leverage across all eight portfolios. Apart from the benefits of increasing the amount of explained variation, matching by industry, sales, and leverage is necessary due to the filtering mechanism and to be consistent with the theoretical development. Equation 10 can be used to show that quantity of output ($Q$), fixed cost ($F$), pension costs ($B^0$), debt ($D^0$), price ($p$) and variable cost ($vc$) [as well as cov($\hat{\alpha}$, $\hat{R}_m$)] all have an impact on beta. Matching on industries\textsuperscript{11} minimizes differences between portfolios caused

\textsuperscript{11} In matching on industry, two-digit SIC codes are used at a minimum and whenever possible four-digit and
by \( p \) and helps minimize differences in \( F \) and \( \text{cov}(\hat{Q}, \hat{R}^m) \).

Matching on total sales as a surrogate for quantity of output minimizes differences in \( \hat{Q} \).\(^{12}\) Finally, matching on \( \hat{R} \) leaves only \( \gamma R^0 \) and \( \nu C \) to differ.\(^{13}\) Realizing that this extensive matching greatly reduces the size of the portfolios, some tests are made to see if any difference exists between portfolios when matched only by industries. If the results differ from the rest of the analysis, further study will be necessary.

Matching across all eight categories is impossible, however, due to the small number of firms in some of the cells. Confounding\(^{14}\) must be used to obtain adequately sized matched portfolios. To be specific, firms from G2 are

three-digit codes are used.

\(^{12}\) Four broad categories of sales are used and all firms within a category are assumed to be matched. Of course, firms are matched as closely as possible within these categories. Furthermore, some judgement decisions are made to allow matches across the categories. For example, it would seem foolish to exclude a set of firms where one had sales of \$1,000 over the critical amount and the other had sales of \$1,000 under the critical amount.

\(^{13}\) Matching on debt is achieved by matching on the total debt to total assets ratio. As a final control, to the extent possible the firms are matched by the ratio of sales to total assets.

\(^{14}\) See Cochran and Cox (1957) for further discussion of confounding than is presented below. In statistical terms, the variable being studied is used as the defining contrast and instead of estimating effects within blocks, the block effect is used as the focal point of the analysis.
matched for industry, sales, total assets, and leverage against firms from G1; firms from G4 against firms from G3, etc. This yields four sets of matched firms; each set measures the effect of UPS but also captures more than the UPS effect. When a contrast captures more than one variable, the other (unintended) variable(s) is called an alias of the variable being examined. Contrasting the portfolios within the four sets of matched firms produces several aliases within each comparison, as summarized in Table 2. In looking at pairs of sub-portfolios, each estimate of UPS (C) has as aliases all of the interactions with itself APC*UPS, UVB*UPS, and APC*UVB*UPS.
Table 2
Alias Structure of Four Sets of Matched Firms

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Number of Firms</th>
<th>Treatment Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>ABC</td>
<td>n&lt;1*</td>
</tr>
<tr>
<td>G2</td>
<td>000</td>
<td>- - - + + + -</td>
</tr>
<tr>
<td>G3</td>
<td>010</td>
<td>n&lt;2*</td>
</tr>
<tr>
<td>G4</td>
<td>011</td>
<td>- + - - + -</td>
</tr>
<tr>
<td>G5</td>
<td>100</td>
<td>n&lt;3*</td>
</tr>
<tr>
<td>G6</td>
<td>101</td>
<td>+ - - - + -</td>
</tr>
<tr>
<td>G7</td>
<td>110</td>
<td>n&lt;4*</td>
</tr>
<tr>
<td>G8</td>
<td>111</td>
<td>+ + - + -</td>
</tr>
</tbody>
</table>

A = APC in column 1
B = UVB in column 2
C = UPS in column 3
* = Matched in pairs for industry, sales, total assets, leverage, net income and the other two ratios.

To measure an effect, the signs in the sets must be opposite. For example, contrasting G2 to G1 estimates C, *15

---

*15 This holds at the single variable level but can be contradicted when considering interaction effects. The normal estimate of the interaction of say AB is [(0,0,f) + (1,1,f) - (0,1,f) + (1,0,f)]; f denotes both levels]. However it is not difficult to conceive of cases where (1,1,f) is different from all of the other groups (including (0,0,f)) due to the interaction of A and B. For example if A is alcohol and B is drug X, either taken alone may not kill the user whereas both taken together results in death.
ABC, negative AC, and negative BC. To eliminate potential confusion over these aliases, confounding is used to split the sets and create super-sub-portfolios. In doing so, the maximum number of firms taken from each set is the minimum of \(n^{1*}, n^{2*}, n^{3*}, n^{4*}\); (* denotes matched). This is necessary to ensure that the other measures do not drive the results. For example if \(n^{1*} = 10\) and \(n^{2*} = n^{3*} = n^{4*} = 1\) little would be gained by creating the super-sub-portfolios (SSPs) unless only one firm was taken from each set of matched sub-portfolios, otherwise the \(G_1 - G_2\) contrast would drive the results. Table 3 illustrates that the contrast between \(S_0\) and \(S_1\) estimates only the UPS effect since all other effects should cancel out within the \(S_0\) and \(S_1\) SSPs.

---

16 The original eight groups of firms in Table 1 are referred to as portfolios. The combined portfolios (as \(S_0\) and \(S_1\)) are referred to as super-sub-portfolios. Last, the two (or more) components of the super-sub-portfolios are referred to as sub-portfolios. For convenience, the acronym SSPs is often used to refer to the super-sub-portfolios and SSP is used to refer to a super-sub-portfolio.
Table 3
Super-Sub-Portfolios

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Number of Firms</th>
<th>Treatment Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>(G1+)</td>
<td>000</td>
<td>n+</td>
</tr>
<tr>
<td>(G3+)</td>
<td>010</td>
<td>n+</td>
</tr>
<tr>
<td>(G5+)</td>
<td>100</td>
<td>n+</td>
</tr>
<tr>
<td>(G7+)</td>
<td>110</td>
<td>n+</td>
</tr>
<tr>
<td>(G2+)</td>
<td>001</td>
<td>n+</td>
</tr>
<tr>
<td>(G4+)</td>
<td>011</td>
<td>n+</td>
</tr>
<tr>
<td>(G6+)</td>
<td>101</td>
<td>n+</td>
</tr>
<tr>
<td>(G8+)</td>
<td>111</td>
<td>n+</td>
</tr>
</tbody>
</table>

A = APC in column 1
B = UVR in column 2
C = UPS in column 3
n+ = min (n<1*>, n<2*>, n<3*>, n<4*>)
+ = equal sizes in sub-portfolios, and matched in pairs for industry, sales, total assets, leverage, net income and the other two ratios.

4.1.3 Risk Analysis Procedures

The portfolio returns are calculated for each month for each portfolio (low and high) in the post-BPTSA period. Three regression equations are run so that ANCOVA procedures can be used to test the equality of the estimated betas.\(^\text{17}\)

\(^{17}\) Keppel (1973), 493-499. The first two could be combined into one equation but the exposition is clearer with them separated.
One of the assumptions in the ANCOVA test is that the variances of the residuals (unsystematic risk) in the two periods are equal, but Schmidtz and Sickles [1977] have shown that when an equal number of observations is used, the ANCOVA test is quite robust with respect to violation of this assumption. Relying on their work, the test for equality of error variance is omitted.

The betas and variances of the residuals for the hypothesis are found from two regression equations. The first regresses the returns for the low portfolio on \( \tilde{R}_m \) and the second regresses the returns for the high portfolio on \( \tilde{R}_m \). The sums of squares for error (SSE) for the first and second regression equations are added together to obtain the SSE for the "full" model. The third regression equation combines the returns from both portfolios and regresses them on \( R_m \) but allows a difference in intercept terms. To allow the different intercept terms, an indicator (dummy) variable is used for one of the portfolios. The third regression is referred to as the "reduced" model. The regression equations are as follows:

16 Their work supersedes that of Toyoda (1974) who required the ratio of the variances to be less than 3 to 1. They found that ratios of 100 to 1 does not greatly change the significance level when an equal number of observations is used.
Low Portfolio

\[ \hat{Y}^0 = \alpha^0 + \beta^0 R_m + \epsilon^0 \]  
\[ E(\hat{Y}^0) = \hat{\alpha}^0 + \hat{\beta}^0 R_m \]  

High Portfolio

\[ \hat{Y}^1 = \alpha^1 + \beta^1 R_m + \epsilon^1 \]  
\[ E(\hat{Y}^1) = \hat{\alpha}^1 + \hat{\beta}^1 R_m \]  

Combined

\[ \hat{Y}^+ = \alpha^0 + I \alpha^* + \beta^+ R_m + \epsilon^+ \]  
\[ E(\hat{Y}^+) = \hat{\alpha}^0 + I \hat{\alpha}^* + \hat{\beta}^+ R_m \]  

where:

\( \alpha \) = intercept term from OLS regression
\( \beta \) = slope term from OLS regression
\( \epsilon \) = error term
\( \alpha^0 \) = low portfolio
\( \alpha^1 \) = high portfolio
\( I \) = indicator variable:
  \( 1 \) = low portfolio,
  \( 0 \) = otherwise
\( + \) = combined
\( * \) = difference in intercept terms

The SSE for the reduced model and the SSE for the full model provide the essential elements to test equality of the betas. The following P* value is used.
where:

* = full model  
+ = reduced model (pooled regression)  
m = number of months in the period

This $F^*$ value will then be compared to the critical $F$ value\(^{19}\) (5.16).

As discussed before, these tests should indicate the information content of the measures in the post-ERISA period. The second analysis to be undertaken examines the changes in the information content of the measures which may be attributable to ERISA.

### 4.2 CHANGES IN INFORMATION CONTENT

The purpose of this section is to examine changes in information content which may have been caused by ERISA. Recalling the formal null hypotheses, we have:

\[ F^* = \frac{SSE^* - SSE^*}{1} / \frac{SSE^*}{m + m - 4} \] (41)

\(^{19}\) A lower critical $F$ value (3.94) could be used since there is only one test being conducted for this part of the study. However, these results are also used when examining the changes in information content where two tests are necessary. A .0253 level is used so that the results can be given at an overall level of significance of .05; $[1-(1-.0253)^2] = 0.04996$. 
data on either side of this date is dropped from the analysis.

The methodology is similar to that used in the prior section except there are now two tests for each measure rather than one. The results from the prior section are used for the post-ERISA results and the same regression equations are run over the pre-ERISA data to provide the results for the pre-ERISA period. The two tests are compared to determine whether or not there was a change in the information content provided by the measures. Recall that if the measure has information content in both periods further analysis is necessary to determine whether or not there was a change in the information content.

4.3 CHANGES IN MAGNITUDE OF MEASURES

As in the preceding section, the first step is to define the event date for the enactment of ERISA; the same date is used here as in that section. It is also necessary to specify a new sample since the data used to construct the prior categories did not consider the pre-ERISA data. Unfortunately, only one year of data is readily available for the pre-ERISA period. Since changes in magnitude are the primary concern, two years (1973—pre-ERISA and

21 The common elements to this and the prior phases will not be repeated except when necessary.
1974—post-ERISA) of data should be adequate to determine which firms were impacted the most. Furthermore, if a longer time period is used it is difficult to pinpoint the change to be at the time ERISA was enacted.

4.3.1 **Specifying the Sample and Treatment Groups**

The sample consists of all firms which: (1) have all three pension cost measures for 1973 [pre-ERISA] and 1974 [post-ERISA] available on the COMPSTAT tape; (2) have return data available for 1969 through 1979 on the PDE tape; (3) reported non-zero values for UPS in both years; and (4) have positive net income in both years. There were 518 firms which meet these criteria. Having defined the sample, the next step is to classify the firms into treatment groups. The following three ratios are used for this purpose.

---

22 The purpose of the restriction to firms with positive values for UPS is to eliminate those firms which have zero values for UPS and UVB which resulted from using an actuarial method which does not separately compute these measures. These "zero-valued" firms are deferred to a later study.

23 The restriction to firms with positive values for net income assists in defining the treatment groups.

24 These ratios were chosen to eliminate differences in size and to be meaningful. For example, the APC to NI ratio in each year should yield a measure of the relative magnitude of APC. Other ratios were used with similar results.
\[
\text{Ratio}_{1j} = \frac{\text{APC}(1974)_{j}}{\text{NI}(1974)_{j}} / \frac{\text{APC}(1973)_{j}}{\text{NI}(1973)_{j}}
\]
\[
\text{Ratio}_{2j} = \frac{\text{UVR}(1974)_{j}}{\text{TA}(1974)_{j}} / \frac{\text{UVR}(1973)_{j}}{\text{TA}(1973)_{j}}
\]
\[
\text{Ratio}_{3j} = \frac{\text{UPS}(1974)_{j}}{\text{TA}(1974)_{j}} / \frac{\text{UPS}(1973)_{j}}{\text{TA}(1973)_{j}}
\]

1st subscript = ratio number
2nd subscript = firm

Note: After the ratios are used to categorize the firms they are referred to by the first subscript only.

These ratios are sorted across firms so that three ordered sets of ratios are obtained. The critical values for categorizing the firms are then obtained by eliminating 5\% of the values on each side of the median ratio. Firms which are above (below) the critical value are labeled as high (low) on that value. Firms are classified into one of 8 categories by these three ratios. For example, firms in the (low,low,low) category are below the median on all three ratios. The following table presents the results of applying this mechanism (low is indicated by 0 and high by 1).
Table 4
Filter Results: Changes in Variables

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Number of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1 000</td>
<td>n&lt;1&gt; (77)</td>
</tr>
<tr>
<td>G2 001</td>
<td>n&lt;2&gt; (35)</td>
</tr>
<tr>
<td>G3 010</td>
<td>n&lt;3&gt; (42)</td>
</tr>
<tr>
<td>G4 011</td>
<td>n&lt;4&gt; (63)</td>
</tr>
<tr>
<td>G5 111</td>
<td>n&lt;5&gt; (83)</td>
</tr>
<tr>
<td>G6 110</td>
<td>n&lt;6&gt; (28)</td>
</tr>
<tr>
<td>G7 101</td>
<td>n&lt;7&gt; (47)</td>
</tr>
<tr>
<td>G8 100</td>
<td>n&lt;8&gt; (54)</td>
</tr>
</tbody>
</table>

As before, confounding is used to create matched super-sub-portfolios. Having specified the mechanism for studying UPS, the statistical procedures used to examine it [Analysis of Covariance (ANCOVA)] are given in the following section. The procedures for APC and UVR are similar.

4.3.2 Risk Analysis Procedures

The basic difference between this and the previous analysis is that now the difference lies in the period under study rather than the level of the measure(s). Before there was one regression for the low portfolio, one for the high portfolio, and one for the combined portfolio. Now there is one for the pre-ERISA period, one for the post-ERISA period, and one in which the two are combined. Specifically, the regression equations are as follows.
Pre-ERISA Period

\[ \hat{\mu} = \alpha + \beta \hat{R}_m + \epsilon \] (42)

\[ E(\hat{\mu}) = \hat{\alpha} + \hat{\beta} \hat{R}_m \] (43)

Post-ERISA Period

\[ \hat{\mu}^* = \alpha^* + \beta^* \hat{R}_m + \epsilon \] (44)

\[ E(\hat{\mu}^*) = \hat{\alpha}^* + \hat{\beta}^* \hat{R}_m \] (45)

Pooled Across Both Periods

\[ \hat{\mu}^+ = \alpha + I \alpha^* + \beta^+ \hat{R}_m + \epsilon^+ \] (46)

\[ E(\hat{\mu}^+) = \hat{\alpha} + I \hat{\alpha}^* + \hat{\beta}^+ \hat{R}_m \] (47)

where:

- \( \alpha \) = intercept term from OLS regression
- \( \beta \) = slope term from regression
- \( \epsilon \) = error term
- \( \epsilon^+ \) = post-ERISA period
- \( I \) = indicator variable:
  - 1 = low portfolio,
  - 0 = otherwise
- \( + \) = pooled
- \( * \) = difference in intercept terms

The same procedures as before are used to calculate the \( F^* \) value. Specifically,

\[
F^* = \frac{\text{SSE}^+ - \text{SSE}^*}{\frac{\text{SSE}^*}{m + m - 4}}
\] (48)

where:

- \( \text{SSE}^+ \) = full model
- \( \text{SSE}^* \) = reduced model (pooled regression)
- \( m \) = number of months in the period
This $F^*$ value is then compared to the critical $F$ value (5.16) with 1 and 2m-4 degrees of freedom under the non-central $F$ distribution. Large values of $F^*$ lead to rejection of the null hypothesis of no difference in betas.

As mentioned above, these tests should indicate the changes in risk correlated with changes in the magnitude of the measures at the time ERISA was enacted.

4.4 **SUMMARY OF METHODOLOGY**

This chapter presented the methodology for examining three sets of tests. The first examines the information content of the measures in the post-ERISA setting. The second examines changes in the information content which may be attributed to ERISA. The third examines changes in risk for portfolios of firms which had differences in the increases of the pension cost measures at the time ERISA was enacted.

In all three phases ratios are used to filter the firms into eight categories. These eight categories provide the basis for matching the portfolios by industry, sales, total assets, leverage, and the other two ratios. Confounding is used to create the super-sub-portfolios for the analysis. After obtaining the super-sub-portfolios analysis of covariance techniques are used to test for equality of betas.
Chapter V

EMPIRICAL RESULTS

The results are discussed in the same order as the tests were covered in the previous chapter. First, the post-ERISA information content study is presented; changes in information content from pre-ERISA to post-ERISA are examined second. The third section presents the results of the tests on the correlation of changes in beta with changes in the magnitude of the measures at the time ERISA was enacted. The last section summarizes the results from all three phases and reconciles any difference(s).

5.1 POST-ERISA INFORMATION CONTENT

Two sets of results are relevant for this phase. First, the results of the matching scheme demonstrate that the blocking, matching, and contrasting mechanism worked reasonably well. That is, to a large extent the super-sub-portfolios (SSPs) differ on the ratios they should differ on and do not differ on the other ratios or blocking factors. The following table summarizes the results of the matching mechanism.
Table 5
Matching/Contrasting Results For the Post-ERISA Analysis

Matches for Annual Pension Cost

| Measure | Portfolio | \( S_0^1 \) | \( S_1^2 \) | Test value \( |t| \)
|---------|-----------|-------------|-------------|-------------
| Ratio1* | 0.085     | 0.193       | 5.95*       |
| Ratio2  | 0.017     | 0.020       | 0.81        |
| Ratio3  | 0.056     | 0.056       | 0.05        |
| APC     | 4,414     | 5,454       | 0.54        |
| UVB     | 6,839     | 6,101       | 0.26        |
| UPS     | 19,300    | 13,319      | 1.09        |
| Sales   | 596,888   | 506,443     | 0.32        |
| TA      | 390,774   | 271,490     | 0.92        |
| CL      | 93,020    | 70,009      | 0.64        |
| LTD     | 77,040    | 46,122      | 1.31        |
| NI*     | 50,406    | 32,470      | 1.09        |
| NI*     | 26,777    | 18,276      | 0.84        |
| Leverage* | 0.431    | 0.443      | 0.32        |
| Leverage* | 0.386    | 0.395      | 0.16        |

Matches for Unfunded Vested Benefits

| Measure | \( S_0^1 \) | \( S_1^2 \) | Test value \( |t| \)
|---------|-------------|-------------|-------------
| Ratio1* | 0.164       | 0.169       | 0.15        |
| Ratio2  | 0.007       | 0.039       | 5.64*       |
| Ratio3  | 0.053       | 0.081       | 2.45*       |
| APC     | 4,144       | 5,359       | 0.85        |
| UVB     | 1,923       | 9,875       | 3.81*       |
| UPS     | 14,436      | 19,941      | 1.09        |
| Sales   | 357,526     | 386,756     | 0.26        |
| TA      | 295,847     | 301,422     | 0.05        |
| CL      | 69,380      | 71,932      | 0.10        |
| LTD     | 69,234      | 67,882      | 0.04        |
| NI*     | 32,591      | 34,094      | 0.15        |
| NI*     | 16,096      | 16,782      | 0.16        |
| Leverage* | 0.473    | 0.446      | 0.84        |
| Leverage* | 0.387    | 0.389      | 0.02        |
Table 5 (continued)

Matches for Unfunded Past or Prior Service Costs

<table>
<thead>
<tr>
<th></th>
<th>S0²</th>
<th>S1²</th>
<th>t</th>
<th>³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio1</td>
<td>.138</td>
<td>.154</td>
<td>.82</td>
<td></td>
</tr>
<tr>
<td>Ratio2</td>
<td>.013</td>
<td>.028</td>
<td>2.44*</td>
<td></td>
</tr>
<tr>
<td>Ratio3</td>
<td>.034</td>
<td>.085</td>
<td>8.14*</td>
<td></td>
</tr>
<tr>
<td>APC</td>
<td>8,664</td>
<td>8,162</td>
<td>.16</td>
<td></td>
</tr>
<tr>
<td>UVB</td>
<td>7,441</td>
<td>15,715</td>
<td>1.73</td>
<td></td>
</tr>
<tr>
<td>UPS</td>
<td>16,245</td>
<td>39,439</td>
<td>2.30*</td>
<td></td>
</tr>
<tr>
<td>Sales</td>
<td>671,121</td>
<td>657,717</td>
<td>.06</td>
<td></td>
</tr>
<tr>
<td>TA</td>
<td>471,553</td>
<td>490,587</td>
<td>.13</td>
<td></td>
</tr>
<tr>
<td>CL</td>
<td>128,306</td>
<td>125,619</td>
<td>.05</td>
<td></td>
</tr>
<tr>
<td>LTD</td>
<td>88,741</td>
<td>93,468</td>
<td>.14</td>
<td></td>
</tr>
<tr>
<td>NIS</td>
<td>57,076</td>
<td>60,067</td>
<td>.17</td>
<td></td>
</tr>
<tr>
<td>NIE</td>
<td>27,272</td>
<td>30,341</td>
<td>.33</td>
<td></td>
</tr>
<tr>
<td>Leverage</td>
<td>.442</td>
<td>.422</td>
<td>.62</td>
<td></td>
</tr>
<tr>
<td>Leverage</td>
<td>.394</td>
<td>.365</td>
<td>.54</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. This is the low valued super-sub-portfolio.
2. This is the high valued super-sub-portfolio.
3. The critical t value for a .05 level of significance is 1.99. Significant t values are indicated by an *.
4. The average ratio for each super-sub-portfolio is given. The ratios are defined on page 35.
5. This is the net income measure used in the study which is basically before depreciation and taxes.
6. This is net income available to common stockholders.
7. This is the ratio of total debt to total assets and includes lease commitments.
8. This leverage ratio excludes lease commitments.

As can be seen from the above table, the SSPs differ on the ratios they should differ on and do not differ on the blocking factors. For APC, the ratios are different even though the underlying measure is not different. This is
partially due to the increased variation when dealing with
the raw measures. For UVR and UPS, both Ratio2 and Ratio3
are different in each test. That is, when filtering by
Ratio2, Ratio3 is also statistically different between the
SSPs. Likewise, when filtering by Ratio3, Ratio2 is also
statistically significantly different between the two SSPs.
Notice, however, that when filtering by Ratio2 the UVB
measure is also statistically significantly different
whereas the UPS measure is not. Likewise, when filtering by
Ratio3 the UPS measure is statistically significantly
different whereas the UVB measure is not. Add to this the
fact that different results are obtained (as is shown
shortly) for UVB and UPS and the lack of separation problem
does not appear to be acute.

It is difficult to claim adequacy of any
matching/contrasting scheme because of the possibility of
spurious correlation with an unidentified dominant\(^1\)
variable. However, the matching scheme used is more
extensive than in most empirical research and includes
relevant dimensions from both theoretical and empirical
perspectives. In short, the matching/contrasting mechanism
may be inadequate and there may exist a superior mechanism
but such inadequacy is not evident on the dimensions used
nor is a superior mechanism evident.

\(^1\) Here dominant is simply taken to mean a variable that is
driving the results.
Although the matching scheme appears quite adequate at ensuring that there is no difference between the SSPs, it creates heterogeneity within each SSP. For example, when studying UPS a small firm from G1 may be matched to a small firm from G0 and a large firm from G1 may also be matched to a large firm from G0. Then S0 (which contains the matched firms from G0) and S1 (which contains the matched firms from G1) will each have a small firm and a large firm in them. Thus the homogeneous matched firms are put into a heterogeneous SSP. This (1) increases the dispersion in estimating beta and (2) creates a cross-sectional SSP which is more representative of the market than individually matched firms (or SSPs of homogeneous firms). The increased dispersion results because each SSP is composed of firms of different sizes, industry classifications, and other factors affecting beta. For this same reason, the SSPs are more representative of the market than they would be if each SSP was composed of firms of the same size, industry classification, etc. The increased dispersion makes it more difficult to reject the null hypotheses of equality of beta but the cross-sectional nature of the SSPs makes the results generalizable to a broader set of firms. On balance, the increased generalizability of the results seems to be more important than the increased difficulty in rejecting the null hypotheses. Furthermore, even with the increased dispersion in estimating beta, the $R^2$ terms were in the
range of .84 to .96 which indicates that the estimates of beta were fairly precise.

Having examined the results of the matching mechanism, the second set of results concern the three null hypotheses of lack of information content for the pension cost measures. Table 6 summarizes the results of these tests.

In Table 6, the SSPs are identified in the same manner they have been discussed in the text; SO refers to the SSP which has the low ratio on that measure and SI refers to the SSP which has the high ratio on that measure. For convenience, the average contrasting ratio for each SSP is repeated from Table 5.

---

2 Paired t tests on the matched firms were also used and similar results were obtained except the significance levels were not as good. This is due to the increased precision from using the portfolio estimates of systematic risk rather than firm estimates of systematic risk. At the portfolio level, the R^2 terms ranged from .84 to .96 whereas at the firm level they ranged from .06 to .63.
Table 6  
Results: Post-ERISA Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
<th>Ratio</th>
<th>Post-ERISA beta</th>
<th>F*</th>
</tr>
</thead>
<tbody>
<tr>
<td>APC</td>
<td>0</td>
<td>.085</td>
<td>.90</td>
<td>1.90</td>
</tr>
<tr>
<td>(n=28)</td>
<td>1</td>
<td>.193</td>
<td>.98</td>
<td></td>
</tr>
<tr>
<td>UVB</td>
<td>0</td>
<td>.007</td>
<td>.98</td>
<td>2.04</td>
</tr>
<tr>
<td>(n=40)</td>
<td>1</td>
<td>.039</td>
<td>.90</td>
<td></td>
</tr>
<tr>
<td>UPS</td>
<td>0</td>
<td>.034</td>
<td>.96</td>
<td>5.51*</td>
</tr>
<tr>
<td>(n=36)</td>
<td>1</td>
<td>.085</td>
<td>.81</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1. The number of firms in the super-sub-portfolios (SSPs) is given in parentheses.
2. As in the text, 0 indicates the low level SSP and 1 indicates the high level SSP.
3. This is the average ratio of the firms in the SSP. The ratios are defined on page 35.
4. The critical F value for a .0235 level of significance is 5.16. Significant F values are indicated by an *.

As can be seen from the above table, only UPS has information content in the post-ERISA period. Neither APC nor UVB has a statistically significant difference between the two SSPs based on the filtering ratios. The lack of information content for the APC measure may be attributable to the fact that the matching scheme makes it extremely difficult to reject the null hypothesis with respect to APC. Since the firms are matched by net income (NI), other cost components must offset the differences in APC. The only way information content could be found is if the components of
net income conveyed more information regarding beta than the net income measure itself. An explanation for the lack of information content regarding the UPS measure will be offered later. The most surprising result though is that the UPS measure has an inverse relationship with beta (as an estimate of systematic risk) which is exactly opposite that predicted by the model in chapter two. The reason for this inverse relationship cannot be determined with certainty but two possible explanations are examined.

First, the Pension Benefit Guaranty Corporation (PBGC) relieves the sponsoring firm of a portion of the liability in case the pension plan terminates. Firms with high UPS measures may have effectively shifted enough of this liability to the PBGC. This could explain the inverse relationship with beta.

3 An attempt was made to use the ratio of APC to net income plus APC (i.e., APC / (NI+APC)) and to match by net income plus APC rather than net income. The matching was not as good on several dimensions but similar results were obtained.

4 First, this is also opposite that predicted if UPS is viewed as a liability. Since the results are opposite of what was expected, the methodology was tested. The ratio of total liabilities to total assets was used as a filter and the same type of matching/contrasting mechanism and testing procedures was applied to those SSPs. The results were consistent with both theoretical models and empirical research. Namely, total debt was found to have a positive correlation with beta. The methodology is therefore assumed not to be reversing the relationships and it appears to be reasonably adequate. Second, other models may exist which explain the results obtained here. For example, consideration of taxes may lead to a different expected relationship which would be consistent with the results; preliminary analysis indicates that it would not. The Black (1980) model (which considers tax effects) suggests that firms should be fully funded to maximize the value of the firm. Though no firms in this sample were
potential liability to the PBGC so that the remaining potential liability is comparable to that of those firms with small UPS measures. In this case, the high UPS firms are increasing their leverage with the government (through the PBGC) bearing the risk of the increased leverage. This shifting of risk should cause the sponsoring firm's risk to decrease.

The second possible explanation is a second order effect of workers. The argument proceeds as follows:

1) The company provides benefits that are higher than normal pension plans.

=> 2) The workers are more satisfied with their jobs than otherwise.

=> 3) There is less likelihood of strikes and other disruptions by the work force.

=> 4) The company has lower total risk.

=> 5) Systematic risk (beta) may also be decreased.

fully funded, the ones which were closer to being fully funded were the ones which were below the median ratio of UPS to TA (Ratio3) and thus were in portfolio 50 (level 0). As indicated in Table 6, this portfolio had a larger beta than the other portfolio. Using the empirical observation that value and beta are negatively related, the Black model does not explain the results obtained here. Under the argument that the assets of the pension fund are inseparable from the assets of the firm, the Black model would explain the results only if firms with large values for UPS also had more assets in the pension plan than firms with small values for UPS. Since UPS is a measure of the difference between promised benefits based on past or prior service and the assets available to meet these promised benefits, firms with large values for UPS do not necessarily have more assets than firms with small values for UPS.
Second order effects such as these are difficult to examine directly and would have to be quite strong to cause the difference in beta. A different second order effect is the possibility that employees may be willing to lend money (through decreased contributions to the pension fund) to the corporation at a lower rate than other suppliers of funds. The reasoning here is as follows:

1) The employer retains more funds internally by funding the minimum amount of UPS. (The employee is indifferent to the funding due to the insurance by the PBGC).

2) The employer increases earnings by using these funds.

3) The employer increases pension benefits (again, insured by the PBGC) as compensation for use of the funds and this compensation is less than would be required by external sources of funds.5

This explains the employee's willingness to lend funds at a lower rate (thus reducing the cost of capital), but it does not directly explain the lower level of beta. To do so would require assumptions beyond the scope of this analysis.

As indicated above, the actual reason for the inverse relationship is not known. However, it is useful to analyze the insurance (by the PBGC) explanation in terms of the model developed in chapter two. This is accomplished by subtracting the insurance premium from the cash flows and

5 Such compensation may not even be necessary because of the insurance by the PBGC. In this case, the arguments revert to the increased leverage explanation given above.
adding the expected insurance benefits. This is accomplished by expanding Equation 4 from chapter two to include both an insurance premium and the expected benefits of the insurance. Doing so yields the following equation.

\[ X = Qp - Qvc - F - \gamma B^0 - \omega I + \psi I \]  

where:

- \( Q \) = quantity of output sold by firm \( j \) in period \( t \)
- \( p \) = price of output for firm \( j \) in period \( t \)
- \( V_c \) = variable cost of output for firm \( j \) in period \( t \)
- \( F \) = fixed cost of output for firm \( j \) in period \( t \)
- \( B^0 \) = unfunded past or prior service costs (UPS) for firm \( j \) at the beginning of period \( t \)
- \( \gamma \) = portion of \( B^0 \) firm \( j \) funds in period \( t \)
- \( I \) = amount of insurance coverage (for pension plan termination) for firm \( j \) in period \( t \)
- \( \omega \) = premium operator to yield dollar amount of the cost of the insurance coverage
- \( \psi \) = benefit operator to yield the expected benefits of the insurance coverage benefits

The premium operator is established under ERISA and is fixed by the PBGC. The current premium is a flat $2.50 per employee. The premium does not consider the financial condition of the pension fund in setting the premium for each firm. For multi-employer plans, recent studies (e.g., Spencer [1978b]) have shown that if risk was properly considered, the premium may need to be in the $80 - $90 range rather than the nominal cost it is now. Similar premiums may be needed for single employer plans.

---

The benefit operator is a function of the amount of the potential liability that will be absorbed by the PBGC in case of plan termination and the probability that the plan will terminate. It is clear that the benefit operator will be greater for the high valued UPS firm than for the low valued UPS firm because both components are larger for the high valued firm. Extending this to the SSPs used in the analysis, the high SSP is getting a much greater benefit from the insurance by the PBGC than is the low SSP. This could be offsetting the increased contributions necessary for the high valued firms so that the net result is a lower beta for the high valued firms. This can be seen by carrying the insurance terms through the analysis in the same manner as before. The end result is:

\[
\beta = \frac{1 + R_f}{E(Q) - \lambda \text{cov}(Q, R_m)} \cdot \frac{\text{cov}(Q, R_m)}{(P + \gamma B_0 + r D_0 + \omega I - \psi I)^\alpha \sigma^2 R_m} \frac{1}{(p - \nu c)}
\]

The above equation shows that the two insurance terms could offset the effects of \( B_0 \). Further study is needed to examine the reasonableness of this interpretation.
5.2 **Changes in Information Content**

The SSPs for the post-ERISA analysis are used in this part of the analysis as well. The matching may not be as good when extended back to the pre-ERISA period but no systematic bias is expected which would change the overall results of the matching/contrasting mechanism.

The following table summarizes the results of the empirical tests in the pre-ERISA period and repeats the results for the post-ERISA period. The table also indicates whether or not there was a change in information content.

---

7 This implicitly assumes the measures have the same relative ranking in the pre-ERISA period as in the post-ERISA period. Classifying the firms in the next phase and comparing the classifications to those in the post-ERISA phase indicate that the correlation coefficient is about .80 for all three measures.
Table 7  
Results: Changes in Information Content

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<td>[1.79]</td>
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Notes:  
1. These are the same portfolios as used in the post-ERISA analysis. The analysis implicitly assumes that the same categories would be formed by using pre-ERISA data. This assumption appears justified from examining selected firms. For convenience, the number of firms in the super-sub-portfolios (SSPs) are repeated in parentheses. 
2. As before, 0 indicates the low level SSP and 1 indicates the high level SSP. 
3. The bracketed figures in this and the next column are the F values for testing equality of betas within each period. The level of significance is set at .0235 so that the two tests (pre and post) have a .05 overall level of significance. Significant F values are indicated by an *.

As can be seen from Table 7, both OVB and UPS had changes in information content; OVB lost information content whereas UPS gained information content. Furthermore, the

* Recall that information content is defined as the ability
information content of UVB was consistent with treating the measure as a liability in the pre-ERISA period (that is, the higher the measure the higher the beta). The low SSP's beta increased from .81 to .98 whereas the high SSP's beta decreased from 1.04 to .90. Notice also that the low SSP for UPS had a change in beta from .88 to .96 whereas the high SSP had a change in beta from .84 to .81. For both measures the low SSPs had an increase in beta whereas the high SSPs had a decrease in beta. This is consistent with neither measure being viewed as a liability in the post-ERISA period.

The overall conclusion suggested by the results is that investors shifted from using the UVB measure in the pre-ERISA period to using the UPS measure in the post-ERISA period. A second conclusion is that the UVB measure was perceived as a liability in the pre-ERISA period and that the UPS measure is perceived as something other than a liability in the post-ERISA period. These "conclusions" are supported by the fact that the PBGC started insuring the potential liability in case of pension plan termination at the same time ERISA was enacted. The PBGC may have eliminated the liability of UVB and created the opportunity to increase leverage at the government's risk thereby to differentiate between the low valued SSP and the high valued SSP in terms of beta. These SSPs were determined by the relative magnitude of the pension cost measures.
increasing the information content of UPS. The increased information content may be due to the fact that UPS indicates how much firms can increase leverage and have the government absorb the risk of this increased leverage.

5.3 **Changes in the Magnitude of the Measures**

Matching is not as critical in this phase as it was in the previous phases since we are examining differences across time rather than differences between SSPs based on pension cost measures. Matching is relevant though if there has been a change (between periods) in the relative betas of labor intensive and capital intensive industries. Reasonable SSP sizes are possible even when matching is used so to eliminate possible problems, matching is also used in this part of the study. The results are summarized in Table 8. Since the matching/contrasting scheme is not as critical as it was before, further comments will not be made and the table of results immediately follows Table 8.

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*Matching is also relevant if the importance of the components in the capital asset pricing model has changed. There is no reason to suspect such a change so this alone is not an adequate reason to match the portfolios.*
<table>
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Table 8 (continued)

Matches for Unfunded Vested Benefits

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### Table 8 (continued)

**Matches for Unfunded Past or Prior Service Cost**

|       | \(SO^1\) | \(SI^2\) | \(|t|^3\) |
|-------|----------|----------|----------|
| **Ratio1:** |          |          |          |
| 1973: | 0.153    | 0.127    | 1.12     |
| 1974: | 0.182    | 0.138    | 1.19     |
| **Ratio2:** |          |          |          |
| 1973: | 0.031    | 0.025    | 0.76     |
| 1974: | 0.037    | 0.036    | 0.07     |
| **Ratio3:** |          |          |          |
| 1973: | 0.085    | 0.063    | 1.54     |
| 1974: | 0.070    | 0.082    | 0.90     |
| **APC:** |          |          |          |
| 1973: | 3,199    | 3,575    | 0.36     |
| 1974: | 3,694    | 4,385    | 0.58     |
| **UVB:** |          |          |          |
| 1973: | 8,423    | 7,756    | 0.12     |
| 1974: | 12,074   | 12,637   | 0.08     |
| **UPS:** |          |          |          |
| 1973: | 18,601   | 18,373   | 0.03     |
| 1974: | 18,502   | 28,151   | 0.92     |
| **Sales:** |          |          |          |
| 1973: | 304,010  | 337,773  | 0.52     |
| 1974: | 359,540  | 392,818  | 0.44     |
| **TA:** |          |          |          |
| 1973: | 233,343  | 257,449  | 0.43     |
| 1974: | 267,832  | 287,925  | 0.32     |
| **CL:** |          |          |          |
| 1973: | 58,026   | 59,365   | 0.10     |
| 1974: | 72,617   | 69,988   | 0.16     |
| **LTD:** |          |          |          |
| 1973: | 43,523   | 54,547   | 0.79     |
| 1974: | 51,836   | 59,791   | 0.53     |
| **NIS:** |          |          |          |
| 1973: | 27,357   | 29,811   | 0.34     |
| 1974: | 30,445   | 34,256   | 0.45     |
| **NIE:** |          |          |          |
| 1973: | 13,957   | 14,323   | 0.11     |
| 1974: | 14,565   | 16,212   | 0.37     |
| **Leverage:** |          |          |          |
| 1973: | 0.419    | 0.450    | 1.17     |
| 1974: | 0.455    | 0.451    | 1.14     |
| **Leverage:** |          |          |          |
| 1973: | 0.415    | 0.438    | 0.90     |
| 1974: | 0.449    | 0.437    | 0.48     |
Table 8 (continued)

Notes:  
1. This is the low valued super-sub-portfolio.  
2. This is the high valued super-sub-portfolio.  
3. The critical t value for a .05 level of significance is 1.99. Significant t values are indicated by an *.  
4. The average ratio for each super-sub-portfolio is given. The ratios are defined on page 49.  
5. This is the net income measure used in the study which is basically before depreciation and taxes.  
6. This is net income available to common stockholders.  
7. This is the ratio of total debt to total assets and includes lease commitments.  
8. This leverage ratio excludes lease commitments.
### Table 9
**Results: Changes in Magnitude of Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
<th>Ratio</th>
<th>Pre-ERISA beta</th>
<th>Post-ERISA beta</th>
<th>P***</th>
</tr>
</thead>
<tbody>
<tr>
<td>APC</td>
<td>0</td>
<td>.82</td>
<td>.87</td>
<td>.96</td>
<td>4.19</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1.42</td>
<td>.88</td>
<td>1.04</td>
<td>9.02*</td>
</tr>
<tr>
<td>UVB</td>
<td>0</td>
<td>N/A^5</td>
<td>.96</td>
<td>1.04</td>
<td>2.37</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>N/A^5</td>
<td>.98</td>
<td>.98</td>
<td>0.00</td>
</tr>
<tr>
<td>UPS</td>
<td>0</td>
<td>.82</td>
<td>.81</td>
<td>.94</td>
<td>10.81*</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1.58</td>
<td>.92</td>
<td>1.00</td>
<td>3.13</td>
</tr>
</tbody>
</table>

**Notes:**
1. The number of firms in the super-sub-portfolios (SSPs) is given in parentheses.
2. As in the text, 0 indicates the low level SSP and 1 indicates the high level SSP.
3. This is the average ratio of the firms in the SSP. The ratios are defined on page 49.
4. The critical F value for a .0235 level of significance is 5.16. The level of significance is set at .0235 so that the two tests have a .05 overall level of significance. Significant F values are indicated by an *.
5. A ratio is not appropriate because the firms which had 0 amounts for UVB in 1973 and 1974 form super-sub-portfolio 0 and the firms which had 0 amounts in 1973 and non-zero amounts in 1974 form super-sub-portfolio 1. Tests on ratios (excluding these firms) yielded similar results.

The results indicate that the small change SSP for UPS had a significant increase in beta and that the large change SSP for APC had a significant increase in beta. None of the other SSPs had a significant change in beta. This is
consistent with the previous results in that UPS has information content and UVB does not have information content. It is inconsistent with respect to APC because this analysis shows APC to have information content whereas the other phases have indicated a lack of information content.

5.4 SUMMARY AND RECONCILIATION OF DIFFERENCES

The tests indicate that UPS has information content in the post-ERISA period and that UVB had information content in the pre-ERISA period. The analysis in phase three was consistent with the results for UPS but indicated that APC had information content whereas the analysis in the other phases indicated a lack of information content for APC. One obvious possibility is that one of the methodologies is inappropriate. That is, one is either failing to capture the information content of APC or the other is over-estimating the information content of APC. Support for the inadequacy of the methodology of phase one can be found in the fact that the order of the betas (estimates of systematic risk) is consistent with APC having a negative correlation with systematic risk but the tests may not be powerful enough to detect a statistical difference. The phase three tests detect such a difference.
A second (and more appealing) interpretation is based on the assumption that the firms which had the biggest increase in APC changed their funding policy for UPS.\(^{10}\) If the large increase SSP consisted of firms which switched from not funding UPS to funding UPS at some amount above the minimum, then the market could be assessing these firms as being more risky for funding UPS when the potential liability is guaranteed by the PBGC. This is consistent with the findings of phase two where the large ratio SSP for UPS had a decrease in beta but the low ratio SSP for UPS had an increase in beta. The firms which chose to keep the UPS measure at a small amount experienced an increase in beta. Which (if either) of these interpretations is correct cannot be readily determined but the evidence seems to support the second interpretation.

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\(^{10}\) The validity of this assumption cannot be readily determined from public sources of information at the current time. Other reasons could be advanced for the large increase in APC but this is certainly a possible explanation. Given the other results, this assumption appears tenable.
Chapter VI

SUMMARY, LIMITATIONS, AND EXTENSIONS

6.1 SUMMARY, LIMITATIONS

The first part of the study examined the theoretical relationship of three pension cost measures to systematic risk through the capital asset pricing model (CAPM). All three measures were found to have an expected positive causal relationship with systematic risk. The results though indicated a negative relationship with beta (which is an estimate of systematic risk) for unfunded past or prior service cost which was explained by adding insurance terms to the original model. The first part of the study also demonstrated the consistency of the model with Rubinstein [1973b] and Hamada [1972]. The limitations to the theoretical model are the same as any other CAPM based theory and are detailed in Appendix B.

The second part of the study examined the relationship of the variables to beta through empirical analysis in an information content framework. The methodology used was similar to that used by Collins and Simonds [1979] except that a filtering device similar to the one in Beaver,
Christie, and Griffin [1980] was used to define the portfolios. The pension cost values were standardized by dividing by some other measure [annual pension cost (APC) by net income (NI), unfunded vested benefits (UVB) by total assets (TA), and unfunded past or prior service cost (UPS) by TA] and the resulting ratios were used to filter the firms into eight categories defined by these ratios. Confounding was used to match firms across categories by industry, size, leverage, net income and the other two ratios to form super-sub-portfolios (SSPs). These SSPs were used in analysis of covariance procedures to test equality of betas between the low and high SSPs in the first two phases and the third phase examined changes in beta from the pre-ERISA period to the post-ERISA period for firms which had different changes in the measures at the time ERISA was enacted. The results indicated that in the post-ERISA period only the UPS measure had information content and in the pre-ERISA period only the UVB measure had information content. The UPS measure acquired information content and the UVB measure lost information content in examining changes from pre-ERISA to post-ERISA. The results for the third phase indicated that the low ratio SSP for UPS had a significant increase in beta as did the high ratio SSP for APC.
One limitation on the empirical analysis (previously discussed in chapter three) concerns the narrow definition of information content used in this study. Since only beta is examined, other dimensions could be different between the SSPs which would allow rejection of the null hypothesis of no information content. However, the nature and meaning of the other dimensions is not obvious and beta is an interesting measure in its own right.

The other limitations on the empirical analysis are common to all market studies, the primary one being the generalizability to other firms. The sample consists of those firms which reported the pension cost measures on the COMPUSTAT tape,\(^1\) had return data available on the PDE tape, and had positive average net income. The results may not be generalizable to firms not meeting these criteria. However, this group of firms typically consists of the larger firms and constitutes a group of interest in itself.

One advantage of market analysis is that it deals with investors in a real environment and therefore avoids some of the generalization issues involved in behavioral experiments. It has a major limitation though in that interpreting the results can be more dangerous than in other

---

\(^1\) Zero-valued UPS firms were eliminated to avoid the problem of having actuarially induced zero measures for UPS and UVB.
types of studies. A fact quite frequently overlooked is that correlation does not imply dependency. There may be yet another unidentified measure which is correlated with the measures under study which is really the dominant variable in the dependency relationship. This limitation cannot be avoided in market analysis but the matching mechanism minimized the possibility of such spurious correlations.

6.2 **EXTENSIONS**

The first extension is to examine the effects of the enactment of ERISA in terms of residual analysis. Under the explanation for the negative correlation of UPS and beta given in this study, a positive residual would be expected for the high ratio SSP at the time ERISA was enacted. Testing for such positive residuals would add further evidence concerning the interpretation used here.

A second extension is to examine differences in the market value of firms which have different funding policies regarding UPS. In brief, Sharp [1978] indicates that to maximize the value of the firm one should underfund UPS to the fullest extent possible whereas Black [1980] indicates the opposite. It would be interesting to test this issue empirically.
Several extensions are possible as a result of FASB 35, "Accounting and Reporting by Defined Benefit Pension Plans," and FASB 36, "Disclosure of Pension Information." Under FASB 36, the UVB measure is replaced by new amounts determined in accordance with FASB 35 [the UPS measure was required by the SEC, not APB 8]. Specifically, the following is required for defined benefit plans:

a. The actuarial present value of vested accumulated plan benefits,

b. The actuarial present value of non-vested accumulated plan benefits,

c. The plans' assets available for benefits,

d. The assumed rates of interest used in determining actuarial present values of vested and non-vested accumulated plan benefits, and

e. The date as of which the benefit information was determined.

All pension plans must disclose the following:

1. A statement that pension plans exist, identifying or describing the employee groups covered,

2. A statement of the company's accounting and funding policies,

3. The provision for pension cost for the period, and

4. Nature and effect of significant matters affecting comparability for all periods presented, such changes in accounting methods (actuarial cost method, amortization of past or prior service cost, treatment of actuarial gains and losses, etc.), changes in circumstances (actuarial assumptions, etc.), or adoption or amendment of a plan.²

² FASB 36, par. 7, 8.
Since the FASB is requiring these items instead of UPS and UVR, comparing the information content of items a-c for defined benefit plans to the results for UPS and UVR would prove interesting.

The methodology used is similar to that of many information content studies and as such suffers from the shortcomings of any market study. Another methodology, such as a behavioral experiment, might be utilized and the results compared. A behavioral experiment could eliminate many of the shortcomings of market research, such as spurious correlation, and would provide additional evidence concerning pension cost values. Furthermore, since market analysis and behavioral experiments are two of the most prominent methodologies used in accounting research, such a comparison could be quite useful.

Another extension could be to analyze pension costs in the public sector. Does accounting for pension costs in the public sector have the same information content as it does in the corporate sector? Limited preliminary evidence indicates that annual pension costs may be more significant in the public sector than in the private sector. Given the increased availability of data on the public sector, this

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3 A preliminary study has been done in the public sector where a correlation was found between the ratio of annual pension costs, total labor costs, and Moody's bond ratings.
seems a possibility for future research.
The Employee Retirement Income Security Act of 1974 (ERISA) represents the most significant change in government regulation of private pension plans in the last 30 years.\(^1\) ERISA imposed requirements on virtually all phases of pension operations from participation to vesting and funding policies. Each of these aspects will be briefly discussed in the following paragraphs.

**Participation and Eligibility Requirements**

Prior to ERISA there was no legal provisions concerning age or service requirements for eligibility. Under ERISA, eligibility must be extended to all full-time\(^2\) employees who:

1) Have reached the age of 25, and

2) Did not become an employed within 5 years of normal retirement age, and

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\(^1\) Arthur Andersen & Co. (1974), p.1. Much of this appendix is attributable to the Arthur Andersen & Co. article.

\(^2\) Full-time is defined as being more than 1000 hours of service during a 12 month period.
3) Did not opt to be non-participating through union (or other good-faith) negotiations, and

4) (a) Have worked for at least one year, or
(b) Have worked for at least three years if immediate full vesting is provided for by the plan once the employee becomes eligible to participate.

These requirements could have had an extreme effect on an employer or it could have had no effect. Prior to ERISA, some plans required long periods of service before an employee became eligible for participation and other plans had service requirements which were even shorter than those of ERISA.

Vesting Requirements

Prior to ERISA, vesting was only required in the event of plan termination or retirement. Under ERISA, an employee must be fully vested in a maximum of 15 years. The following methods may be used for determining the vesting percentages for employees:

1) Ten year vesting—an employee becomes 100% vested after 10 years of service. No interim vesting is required unless the provisions for vesting are discriminatory to one or more classes of participants.

2) Five to fifteen year vesting—an employee becomes 25% vested after 5 years of service and the percentage increases by 5% for the next 5 years. After 10 years, the percentage increases by 10% until after 15 years the employee is fully vested.
3) Rule of 45—this approach considers both age and length of service and generally leads to smaller vested amounts than the other two methods when the work force is primarily composed of younger employees. Notwithstanding the age-service combination, an employee must be 50% vested at the end of 10 years of service with the percentage increasing 10% per year until 15 years of service (at which time the employee will be 100% vested).

As before, these vesting requirements could have significantly impacted some firms and could have had no impact on others.

Funding Requirements

ERISA was the first legislation to require funding of the past or prior service costs. Specifically, the following minimum funding requirements were established:

1) Normal costs are to be funded currently.

2) For plans in existence as of January 1, 1974, past or prior service costs arising before September 2, 1974\(^3\) are to be amortized over 40 years.

3) Past or prior service costs of plans established after January 1, 1974 and changes in past or prior service costs arising from changes in the plan after January 1, 1974 are to be amortized over 30 years.

4) Experience gains and losses (determined at least every three years) are to be amortized over 15 years.

\(^3\) This includes adjustments required by the provisions of ERISA.
5) Changes in past or prior service costs arising from changes in the plan’s actuarial assumptions are to be amortized over a period of 30 years. 

The Secretary of Labor may waive the amortization requirements in cases of substantial business hardship for not more than 5 years in any 15 year period. Such waivers are to be amortized over a period not to exceed 15 years. Even with this possible waiver by the Secretary of Labor, these funding provisions represent a significant departure from prior requirements and could have substantially impacted the funding policies of some firms. Some firms, however, were funding the past or prior service costs at a much faster rate and were not impacted by these minimum requirements. These firms may have been effected by the limitations for deductible contributions to pension plans. Generally, the maximum annual deduction cannot exceed the greater of:

1) The amount necessary to satisfy the minimum funding requirements discussed above, or

2) The amount necessary under the plan to provide for all employees the remaining unfunded cost of their past and current service credits if they were distributed over the remaining service of such employees, or

3) Normal cost plus 10% of the past or prior service cost (including interest charges).

*Multi-employers are subject to similar provisions but are typically given slightly longer periods over which to amortize the above items.*
These minimum and maximum funding provisions significantly changed the law regarding funding of past or prior service costs. As discussed above, these changes in the legal requirements may have impacted the firms in quite different ways.

Plan Termination Insurance Provisions

ERISA established the Pension Benefit Guaranty Corporation (PBGC) to insure the benefits promised by pension plans. The PBGC establishes maximum amounts that are covered by the insurance and determines the insurance premiums to be paid by the employers. Initially the PBGC set the premium at $1.00 per employee participating in a pension plan for single employer plans. The employer still shares the risk of plan termination because the employer is liable to the PBGC to the extent that the present value of guaranteed benefits exceeds the value of plan funds at the time of plan termination. This liability (which is treated

5 Other provisions set some further limitations on the maximum deductible amounts but the major ones are given above. Any amounts in excess of the maximum deductible amount for a year can carry forward to the next taxable year(s) and be deductible in that year(s).

6 This amount has risen to the current level of $2.50 per employee. Multi-employer plans initially had an insurance premium of $.50 because it was felt that these plans were less likely to go bankrupt than single employer plans. The provisions were so lenient for multi-employer plans that many companies withdrew from the plans and multi-employer plans are currently in a greater danger of bankruptcy than single employer plans.
like a Federal tax lien) cannot exceed 30% of the employer's net worth, as determined by the PBGC. Net worth is apparently defined as the market value of equity rather than in accordance with GAAP.

It is interesting to note that the PBGC does not determine the insurance premiums in accordance with the underlying risk of plan termination, rather a flat premium is charged per employee covered by the pension plan. Though discussed more fully in chapter five, it seems fairly obvious that employers which have the greatest likelihood of plan termination receive greater value from this insurance than employers who have a small likelihood of plan termination.
Rubinstein [1973a] presented an excellent discussion on the assumptions behind the CAPM model; his comments are presented intact.¹

The most important assumptions are (1) its single-period context, (2) no restrictions on short-selling and borrowing, and (3) a perfect and competitive securities market. However, Fama has demonstrated that even though an individual has a concave multiperiod utility function, he will nonetheless behave in the first period as if he possesses some concave single-period utility function. This theorem is significant since if security returns are assumed normally distributed and intertemporally statistically independent, the CAPM applies even in a multiperiod setting where $\tilde{R}$ represents a first period rate of return. Nonetheless, the model remains incapable of valuing irregular or non-perpetual income streams over time and hence has not rigorously been applied to the analysis of dividend policy and capital budgeting projects with

¹ Double spacing is used for this extensive quotation to make it easier to read.
multiperiod receipts. Only if firms can in some way estimate the probability distribution of the market value of a project at the end of the first period (without knowing future discount rates) and sale of the project at that time does not result in synergistic losses will the mean-variance model be appropriate. However, this model should not be criticized too heavily on this account since the present failure of theorists to produce any multiperiod (i.e., permitting portfolio revision over time) security valuation model under uncertainty consistent with maximizing expected utility [see Hakansson (1969)] is very likely the most pressing theoretical problem in the field of finance.

The assumption of a perfect securities market precludes personal or corporate taxes, brokerage fees, underwriting costs, bankruptcy penalties, or other types of transactions costs as well as indivisibilities of securities. Relaxation of this assumption provides no analytical complications provided the imperfection is confined to a proportional reduction (possibly different for different securities) in the rate of return on a security; that is, stochastic constant returns must prevail. Otherwise, the necessary first order conditions in the Appendix [to his paper] must be drastically revised. However, if certain imperfections are admitted (as we will do in the case of proportional corporate income taxes) the capital structure and merger
irrelevancy propositions do not strictly hold. Bankruptcy penalties, though not proportional corporate income taxes, create an incentive to merge since mergers almost invariably diminish the probability of bankruptcy. However, proportional personal income taxes do not affect any of the conclusions in this essay.

With a competitive securities market, the same security investment opportunities are available to all investors and no investor believes he can influence the rate of return on any security by his market transactions. No such assumption is made for firms in Sections I and III. However, in Section II, a firm's capital budgeting decisions are assumed to have negligible impact on the capitalized opportunities of other firms. The implications of relaxing the assumption of a competitive securities market have received little attention in the theoretical literature.

Rubinstein [1973a] demonstrates that the assumption of (4) the existence of a risk-free (i.e. zero variance) security is not substantive provided at least two risky securities exist in which case the symbol $R_f$ in this paper may be replaced at every point by $E(\tilde{R}_p)$ where $p$ is a portfolio with $\text{cov}(\tilde{R}_p, \tilde{R}_m) = 0$. The strong short-selling assumption, by circumventing the issue of personal bankruptcy, makes this possible. Restrictions on
short-selling leading to Kuhn-Tucker conditions have been examined by Lintner [1965, 1969].

If the assumption of (5) homogeneous subjective probabilities is omitted, as Lintner has shown, a concept similar to the market value of risk remains well-defined. However expected rates of return and covariances must be replaced by weighted averages. Furthermore, the convenient separation property of the model (i.e. all individuals regardless of differences in wealth levels or preferences, divide their wealth between the same two mutual funds, one of which is risk-free and the other the market portfolio of risky securities) no longer holds. As Stiglitz proves, this failure of the separation property invalidates the Modigliani-Miller Proposition I in the presence of risky corporate borrowing. However, if corporate debt is risk-free, the proposition still holds. A similar qualification applies to the asset expansion propositions; see Lintner [1971] and Myers [1968].

The assumption that (6) all individuals evaluate portfolios by only two parameters, expectation and variance of future wealth, if omitted leads to a more complex security valuation equation which nonetheless preserves many of the characteristics of the simpler mean-variance case; see Rubinstein [1973b]. However, in this case the
separation property is more difficult to obtain. Finally, if the assumption of (7) risk aversion is omitted, the CAPM remains necessary but no longer sufficient for market equilibrium.
Appendix C

FORMULATION OF MODEL FROM ACCOUNTING

Accounting concepts and reporting procedures underly the models presented in chapter two. The concept of contribution margin serves as the starting point. Contribution margin is the excess of sales revenue over variable costs and is the amount provided (by sales) to cover fixed costs and make a profit. In other words, deducting fixed costs from the contribution margin yields net income before interest and taxes (NIBIT) as shown in Exhibit C-1.

1 The elementary accounting concepts used here are found in most basic texts; Garrison (1979) and Meigs & Meigs (1979) served as a basis for the concepts used here. Also note that the term contribution margin is often used interchangeably to refer to the per unit amount and the total contribution margin. Here, lower case letters will denote the per unit contribution margin and upper case letters will denote total contribution margin.
Exhibit C-1
Net Income Before Interest and Taxes

<table>
<thead>
<tr>
<th>Description</th>
<th>Formula</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Sales (Quantity x price) (Qp)</td>
<td>100 x 10</td>
<td>$1,000</td>
</tr>
<tr>
<td>Less Variable Costs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>(Q x variable costs)</td>
<td></td>
</tr>
<tr>
<td>Selling and Administrative</td>
<td>(Qvc) 100 x 6</td>
<td>600</td>
</tr>
<tr>
<td>Contribution Margin (Q(p-vc) or Qcm)</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>Less Fixed Costs (excluding interest and pension cost¹)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>(P)</td>
<td>170</td>
</tr>
<tr>
<td>Selling and Administrative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed Pension Cost¹</td>
<td>(FPC)</td>
<td>30</td>
</tr>
<tr>
<td>Net Income Before Interest and Taxes (NIBIT)</td>
<td></td>
<td>$200</td>
</tr>
</tbody>
</table>

¹ Interest and amortization on the supplemental present values.

Deducting interest and taxes from NIBIT yields net income available to shareholders. Interest is equal to the interest rate times the amount of debt (rD₀) and taxes are equal to the tax rate times the net income before taxes (T = r*NIBIT). Therefore, net income is equal to one minus the tax rate times net income before taxes (subtraction performed first): NI = (1 - r)*NIBIT. The fixed pension cost can be expressed as a function of the interest rate and the portion of the supplemental present values that are funded in period t: FPC = f(r, YB₀). These concepts are illustrated in Exhibit C-2.
### Exhibit C-2
Net Income Available to Shareholders

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Sales (Op) 100 X 10</td>
<td>$1,000</td>
</tr>
<tr>
<td>Less Variable Costs (Qvc) 100 X 6</td>
<td>$600</td>
</tr>
<tr>
<td>Contribution Margin (Qcm or CM)</td>
<td>$400</td>
</tr>
<tr>
<td>Less Fixed Costs (F)</td>
<td>$170</td>
</tr>
<tr>
<td>Less Fixed Pension Cost (PPC)</td>
<td>$30</td>
</tr>
<tr>
<td>Net Income Before Interest and Taxes (NIBIT)</td>
<td>$200</td>
</tr>
<tr>
<td>Less Interest</td>
<td>$40</td>
</tr>
<tr>
<td>Net Income Before Taxes (NIBT)</td>
<td>$160</td>
</tr>
<tr>
<td>Less Taxes (T)</td>
<td>$70</td>
</tr>
<tr>
<td>Net Income (NI)</td>
<td>$90</td>
</tr>
</tbody>
</table>

Net Income Available to Shareholders (NIAS) $90

The simple contribution format income statement has been expanded by showing interest and pension cost on the supplemental present values separately from the other fixed costs. If direct costing (the basis for contribution margin statements) becomes acceptable for external reporting, a format similar to that in Exhibit 2 provides a means of calculating NIAS. Since Exhibit 2 should be evident to most accountants, it will be converted into equation form without further explanation.

\[ \text{Op} - \text{Qvc} - \text{F} - \text{I} - \text{T} - \text{PPC} = \text{NIAS} \]  \(1\)
Applying the transformations discussed above yields Equation 2:

\[(Q_D - Q_{vc} - F - rD^0 - B)(1 - ) = NIAS\]  \hspace{1cm} (2)

This is clearly related to the formulation contained in chapter two with taxes added. Although not considered in chapter two for convenience, the addition of taxes to the model should yield the same results.
Appendix D

AN EXTENSION OF THE MODEL TO EXAMINE OUTPUT

Though not the primary purpose of this dissertation, the model can also be used to explain that output has a negative relationship with systematic risk and to show how industry differences might impact systematic risk. These two facts have long been known but have not previously been modeled. The following illustrates the effects of output on systematic risk.

a) Assume \( \tilde{Q}^+ = \tilde{Q} + k \)

\[ \implies E(\tilde{Q}^+) = E(\tilde{Q}) + k \]

and \( \implies \text{cov}(\tilde{Q}^+, R_m) = \text{cov}(\tilde{Q}, R_m) \)

Substituting \( E(\tilde{Q}^+) \) for \( E(\tilde{Q}) \) in the main equation (10) yields:

\[
\beta = \frac{1 + R_f}{\text{cov}(\tilde{Q}, R_m)} \cdot \frac{\text{cov}(\tilde{Q}, R_m)}{\sigma^2 R_m} \cdot \left( \frac{E(\tilde{Q}) + k - \lambda \text{cov}(\tilde{Q}, R_m)}{(p - vc)} \right)
\]

Similar to the analysis in chapter two if \( k \) is negative then \( \beta^+ > \beta \); the reverse also holds. Therefore mean shifts in output impact beta and a negative relationship holds.

b) Assume \( \tilde{Q}^+ = a\tilde{Q} \)

\[ \implies E(\tilde{Q}^+) = aE(\tilde{Q}) \]

and \( \implies \text{cov}(\tilde{Q}^+, R_m) = a\text{cov}(\tilde{Q}, R_m) \)
Substituting $E(Q^+)$ for $E(Q)$ and $\text{cov}(Q^+, \tilde{R}_m)$ for $\text{cov}(Q, \tilde{R}_m)$ yields:

$$
\frac{1 + R_f}{aE(Q) - a \lambda \text{cov}(Q, \tilde{R}_m) - \frac{\text{acov}(Q, \tilde{R}_m)}{(p-vc)}} = \frac{\text{cov}(Q, \tilde{R}_m)}{\sigma^2 R_m} \quad (2)
$$

Dividing numerator and denominator by $a$ yields:

$$
\frac{1 + R_f}{E(Q) - \lambda \text{cov}(Q, \tilde{R}_m) - \frac{\text{acov}(Q, \tilde{R}_m)}{a(p-vc)}} = \frac{\text{cov}(Q, \tilde{R}_m)}{\sigma^2 R_m} \quad (3)
$$

The analysis can be made similar to that for variable cost by assuming $a < 1$. If $a < 1$, then $a(p-vc) < (p-vc)$ and the analysis in chapter two yields $\beta^+ > \beta$. Therefore proportional changes in output also have a negative relationship to systematic risk.

Industry differences in any of the cost components (or covariance term) can be traced to differences in beta through use of this model. For example, differences in the per unit contribution margin $(p-vc)$ would lead to differences in beta as would differences in fixed cost. Of course, the effects could be offsetting so that no difference would result. Comparing two securities where one had both higher fixed cost and contribution margin may result in no difference in beta. To illustrate this point, consider the following cases.
Case 1

Market Variables

\[ R_f = .12 \]
\[ \sigma_{R_m} = .55 \]
\[ E(R_m) = .18 \]

Firm Variables

<table>
<thead>
<tr>
<th></th>
<th>Firm A</th>
<th>Firm B</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \hat{E}(Q) )</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>( P )</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>( \gamma_{BO} )</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>( tD_0 )</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td>( p-vc )</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>( \text{cov}(Q,R_m) )</td>
<td>4,950</td>
<td>4,950</td>
</tr>
</tbody>
</table>

\[ \implies \beta = 1.26 \]

Case 2

Market Variables

\[ R_f = .12 \]
\[ \sigma_{R_m} = .55 \]
\[ E(R_m) = .18 \]

Firm Variables

<table>
<thead>
<tr>
<th></th>
<th>Firm A</th>
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<tr>
<td>( \text{cov}(Q,R_m) )</td>
<td>4,950</td>
<td>4,950</td>
</tr>
</tbody>
</table>

\[ \implies \beta = 1.26 \]

From examining Case 1, it is clear that the difference is \((p - vc)\) resulted in a difference in beta, as calculated by equation 10. However, Case 2 illustrates that the two costs may offset one another so that no difference in beta will be found from the model. There are a number of other
combinations of costs (and other parameters) that could lead to differences in beta, as in Case 1, or could offset one another so that no differences would be found, as in Case 2.
BIBLIOGRAPHY


