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A behavioral view of current cost accounting information in predicting failures.

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A BEHAVIORAL VIEW OF CURRENT COST ACCOUNTING INFORMATION IN PREDICTING FAILURES

A Dissertation Presented

By

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A BEHAVIORAL VIEW OF CURRENT COST ACCOUNTING

INFORMATION IN PREDICTING FAILURES

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ABSTRACT

A Behavioral View of Current-Cost Accounting Information in Predicting Failures

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The question of whether to switch from historical costs to current-costs for financial reporting has been a controversial issue for a long time. In order to justify the change, the current-cost information must have some additional benefits not present in historical cost information. Current-cost information should have the capability of enabling users of financial reports to make better decisions than those made with historical cost reports. This research project investigated the effects of current-cost reporting on the prediction of bankruptcy by a group of bankers.

The bankers were presented with four financial ratios for a sample of bankrupt and nonbankrupt firms. The bankers were asked to make a sequence of subjective probability judgments that a firm will fail after viewing the financial ratios from three information classes for two time periods, one and three years prior to bankruptcy. The three information classes were: (1) Historical cost, (2) Current-cost, and (3) Both historical cost and current-cost. The dependent variable was the likelihood odds ratio which was inferred from the bankers'

probability judgments using the odds form of Bayes' theorem. The likelihood odds ratios were used to measure the relative impact and accuracy of the direction of the probability revisions for the financial ratios from the three information classes. The likelihood odds ratios were tested for significant differences between the three information classes.

The financial ratios owners' equity/total debt and net income/total assets appeared to provide the most useful and accurate information when presented to the subjects on a current-cost basis. The financial ratio current assets/current liabilities appears to provide the most useful information when presented on a historical cost basis. There was no significant difference in the impact of the three information classes for the financial ratio current assets/total assets.

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CHAPTER I

INTRODUCTION

Current Cost Reporting Today

One of the major issues in the accounting literature has been the selection of the proper measuring unit. One aspect of the issue questions whether financial statements should continue to be prepared on a historical cost basis or whether financial statements should be based on some alternative measurement criterion. A competing measurement base that is endorsed by many throughout the accounting profession is replacement cost accounting.

The British Government Committee on Inflation Accounting in September 1975 recommended that financial statements be based mainly on replacement cost.[1] Furthermore, the Committee recommended that the replacement cost statements be the only published accounts. The Accounting Standards Committee in an exposure draft (ED 18) published in 1976, recommended that all but very small businesses change to replacement cost accounting by 1980.[2] These proposals were however rejected by the committees before their final implementation dates.[3]

A similar situation exists in the United States where there is strong support for financial statements based on replacement costs. The Securities and Exchange Commission (SEC) issued an exposure draft in 1975 that required the reporting of replacement cost information on inventories, cost of sales, gross property, plant and equipment, and depreciation based on the replacement cost of the firm's assets.[4] Then in March 1976, the SEC made it mandatory for certain firms under their jurisdiction to report the information described in the exposure draft.[5] Those firms that must disclose the replacement cost information are those with inventories, gross property, plant and equipment greater than $100 million and those assets comprising 10 percent or greater of the total assets. The required replacement cost disclosure in Accounting Series Release No 190 includes the estimated current replacement cost of inventories at the end of each fiscal year for which a balance sheet is required and the approximate cost of sales and depreciation based on the replacement cost of the firm's assets.

There also exists strong support for replacement cost accounting from professional accountants. Touche Ross & Co., in their presentation, Economic Reality in Financial Reporting, makes a strong case for the presentation of replacement cost information and urges that this method of financial reporting be adopted.[6]

The Task Force on a Conceptual Framework for Financial Accounting and Reporting addresses the issue of price-change accounting, but carefully avoids taking a position that supports any specific measurement base.[7]

The Problem

There currently exists no widely accepted evidence of relative merit between financial statements prepared on a historical cost basis and those presented on a replacement cost basis. A priori arguements to the superiority of various accounting measurement bases have appeared frequently in the accounting literature over the past forty years. Unfortunately, little progress has been made at this time that helps to establish the relative merit of the proposed measurement bases. What little research that has been done, gives evidence that is conflicting as to the relative merit of replacement cost information against historical cost information. Much of the failure to progress toward resolution of the problem may be attributed to two closely related factors: (1) most criteria for the evaluation of accounting alternatives are not easily testable, and (2) there has been little empirical testing of accounting choices relative to the specific criteria that are testable.

Predictive Ability as a Means of Assessing Accounting Alternatives

Accounting researchers recognize the problems in establishing the relative merits of competing accounting alternatives. Beaver, Kennelly and Voss have suggested the following criterion for the evaluation of relative merit between accounting alternatives:

> One criterion being employed by a growing body of empirical research is predictive ability. According to this criterion, alternative accounting measurements are evaluated in terms of their ability to predict events of interest to decision makers. The measure with the greatest predictive power with respect to a given event is considered to be the "best" method for that particular purpose.[8]

In 1973, the AICPA's Study Group on the Objectives of Financial

Statements reported that:

> The basic objective of financial statements is to provide information useful for economic decisions.[9]

Use of the predictive ability criterion in the evaluation of accounting alternatives can be thought of as a measurement device to ascertain how effectively accounting alternatives are meeting their function of providing information useful for making economic decisions. Information content is a measure of the reduction of uncertainty surrounding a future event by the presence of datum d_i. Beaver, Kennelly and Voss state:

> Predictive power is defined as the ability to generate operational implications and to have those predictions subsequently verified by empirical evidence. More precisely, a prediction is a statement about the probability distributions of the dependent variable (the event being predicted) conditional upon the value of the independent variable (the predictor).[10]

Therefore, predictive ability is a measure of the information content of accounting data.

Behavioral Approach to Decision Making in Accounting

In the context of making economic decisions, predictive ability is important because predicting is a necessary, and prior condition for decision making. People, however, make decisions, therefore the behavioral aspects of using accounting data for predictive purposes must be given attention. The AAA Committee on Accounting Theory Construction and Verification comments upon this important aspect:

> ... thus far the predictive ability approach has been an essentially impersonal approach to the information needs for decisions; it has ignored the behavioral interactions of the accounting data and the decision maker.
> If we define the objective of the accounting process to be the production of numbers that possess information content... an evaluation of valuation bases must (indirectly or directly) evidence cognizance of users' reactions to accounting numbers.[11]

The Committee is suggesting that the predictability criterion be used in conjunction with users' decision models. The committee introduces a framework which may be used to identify the prediction models implicitly used by decision makers; they suggest that the identification of such models is an important step in the evaluation of alternative valuation bases. The Committee suggested at that time that the Brunswick Lens model would be a useful tool in looking at decision makers and accounting alternatives.

Then, in 1977, the 1976-77 AAA Committee on Human Information Processing expanded their identification of models that would be helpful in the evaluation of accounting alternatives. The Committee at that time identified the Bayesian approach to Human Information Processing as a useful model for looking at decision makers and accounting alternatives. The Committee stated in their report:

> If one's research requires a measure of optimality, or relative accuracy, application of either the Bayesian or lens model approach is needed. Further, if a measure of data diagnosticity is necessary, the lens model or Bayesian approach is required.[12]

The Focus of the Current Study

This research project utilizes the Bayesian Human Information Processing model in an attempt to ascertain the information content present in current cost financial statements versus the information content present in historical cost financial statements with respect to assisting in the prediction of business failures. The Bayesian model relies upon the assumption that people process information in a Bayesian manner, i.e., that information causes their subjective probability judgments about the possibility of a future events occurrence to be revised after viewing information in the manner specified by Bayes' Theorem. The decision to be made by experimental subjects is the prediction of failure from a sample of failed and nonfailed firms. Failed firms refer to those firms that are legally bankrupt and either placed in receivership or have been granted the right to reorganize under the provisions of the National Bankruptcy Act. The experimental model will test whether the same decision makers react differently when presented with current cost financial information either by itself or as a supplement to conventional historical cost information as contrasted against those decisions based solely on historical cost financial information. The financial information will be presented in the form of five financial ratios which will be presented sequentially to the subjects. The subjects will be asked to make a probability judgment about failure for the firm after viewing each financial ratio. Bayes' Theorem will then be used to examine the subjects' subjective probability distributions to ascertain the relative information content of the financial ratios prepared on the alternative measurement bases. Since the firms used in the study constitute a sample of actual failed and nonfailed firms, it will be possible to examine the alternative measurement bases in light of the predictability criterion.

Literature on Business Failure Prediction

The ability to predict corporate failure is important from both the private and social points of view, since failure is obviously an indication of resource misallocation. An early warning signal of probable failure will enable both management and investors to take preventive measures. Corrective actions through operating policy changes, reorganization of financial structure, and early voluntary liquidation can shorten the time losses are incurred and thereby improve both private and social resource allocation.[13]

A number of researchers have investigated the topic of the prediction of business failures. Initial studies in the area were of a univariate nature. The object of the empirical research was to compare the financial ratios of failed firms with those of nonfailed firms to detect systematic differences which might assist in predicting failure.

Descriptive studies on business failures. FitzPatrick, in 1932 examined 19 pairs of failed and nonfailed firms and found persistent differences in the financial ratios for the period one to three years before failure.[14] Winakor and Smith in 1935 using a sample of 183 failed firms reported a deterioration in the mean value of financial ratios of failed firms for ten years prior to failure with an increasing deterioration rate as the failure came closer in time.[15] Mervin, using a sample of over 900 firms demonstrated that a ratio difference existed as far back as six years prior to failure.[16] Although there exists various statistical shortcomings of these earlier studies, systematic differences between the ratios of failed and non-failed firms were established. These studies were descriptive in nature however, and did not attempt to directly address the problem of failure prediction.

Univariate predictive models of business failure. The prediction of business failure via ratio analysis depends upon the assumption that the ratios for failed and nonfailed firms are drawn from different ratio distributions. This appears to be the case, since many empirical studies have developed highly predictive discriminating functions which have relied upon this difference. Initial studies were of a univariate nature, such as Beaver's study which employed ratio analysis in predicting business failure.[17] Beaver's 1966 study utilized a sample of 79 firms that failed and 79 nonfailed firms. For each failed in the sample, a nonfailed mate from the same industry and of similar size was selected. This pairing was done to control for systematic size and industry differences in financial ratios that might cloud the relationship between failed and nonfailed businesses. Beaver's study was restricted to financial ratios so that the consideration of non-accounting data was excluded from the experimental design. Financial statement data for the failed firms were available for five years before the failure date. The data for the nonfailed mates was selected for the same time periods of the failed firms. Thirty financial ratios were computed for each firm in the sample. A comparison of the mean ratios for the failed and nonfailed firms matched the findings of earlier studies:

> The difference in the mean values is in the predicted direction for each ratio in all five years before failure.
> The trend line of the nonfailed firms has a zero slope and the deviations from the trend line are small. Yet the deterioration in the means of the failed firms is very pronounced over the five year period...
> The evidence overwhelmingly suggests that there is a difference in the ratios of failed and nonfailed firms.[18]

To examine the possibility of predictive power of the financial ratios, Beaver employed various predictability tests, such as the dichotomous classification test, which predicts a firms failure or nonfailure status based upon the knowledge of a given financial ratio. Generally, the mixed ratios, those with income or cash flow in the numerator and balance sheet figures in the denominator turned out to be the best predictors.

The Bayesian approach in ratio analysis. In addition to the dichotomous classification test, Beaver performed a Bayesian analysis using the financial ratios. Financial ratios can be viewed as a way of assessing the likelihood of failure. Beaver prepared histograms in order to construct the likelihood distributions for the financial ratios. Figure 1 shows the histograms from Beaver's study for the cash flow to total-debt ratio. (Figure 1 is located on the following 2 pages).

It can be seen from the histograms that the distribution of non-failed firms is fairly stable over time. The distribution of failed firms shifts farther to the left as the failure comes closer in time, while the gap between failed and nonfailed firms becomes greater. Five years before failure there is a great deal of overlap between the two distributions which makes failure prediction more susceptible to error, while one year prior to failure, the overlap is not so great which increases prediction accuracy.

The study of financial ratios as predictors of failure is placed in its broadest context through discussion of the likelihood distributions. Using the likelihood distributions is a Bayesian approach in the sense that the problem of predicting failure can be viewed as the assessment of the probability of failure conditional upon the value of the financial ratio (i.e., $P(\theta_i \mid d_j)$ where θ_i = fail or not fail $\bar{\theta}$, and d_j = ratio j). In arriving at estimates of the conditional probability of failure, the possible events are viewed as being dichotomous, either fail or not fail. Prior to looking at the financial ratios, prior probabilities are formed. Prior probabilities, $P(\theta)$ and $P(\bar{\theta})$ may be based upon several factors, such as the unconditional probability of failure for all firms, industry, asset size, or quality of management.[19]

After the ratio has been observed, assessments of the likelihoods of failure and nonfailure are formed, $P(d_j \mid \theta_i)$. The likelihood is the

Figure 1

Beaver's Univariate Study

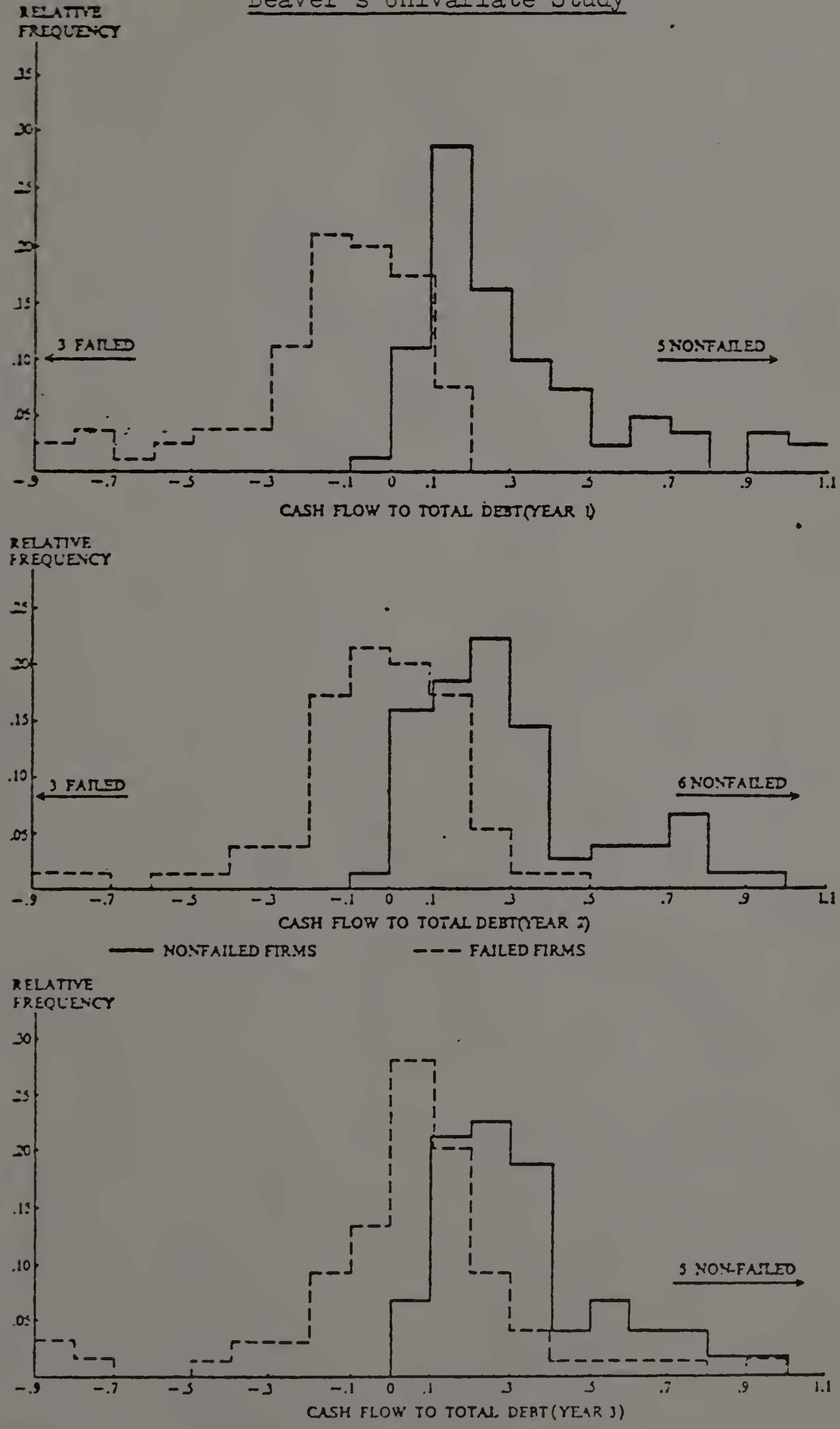
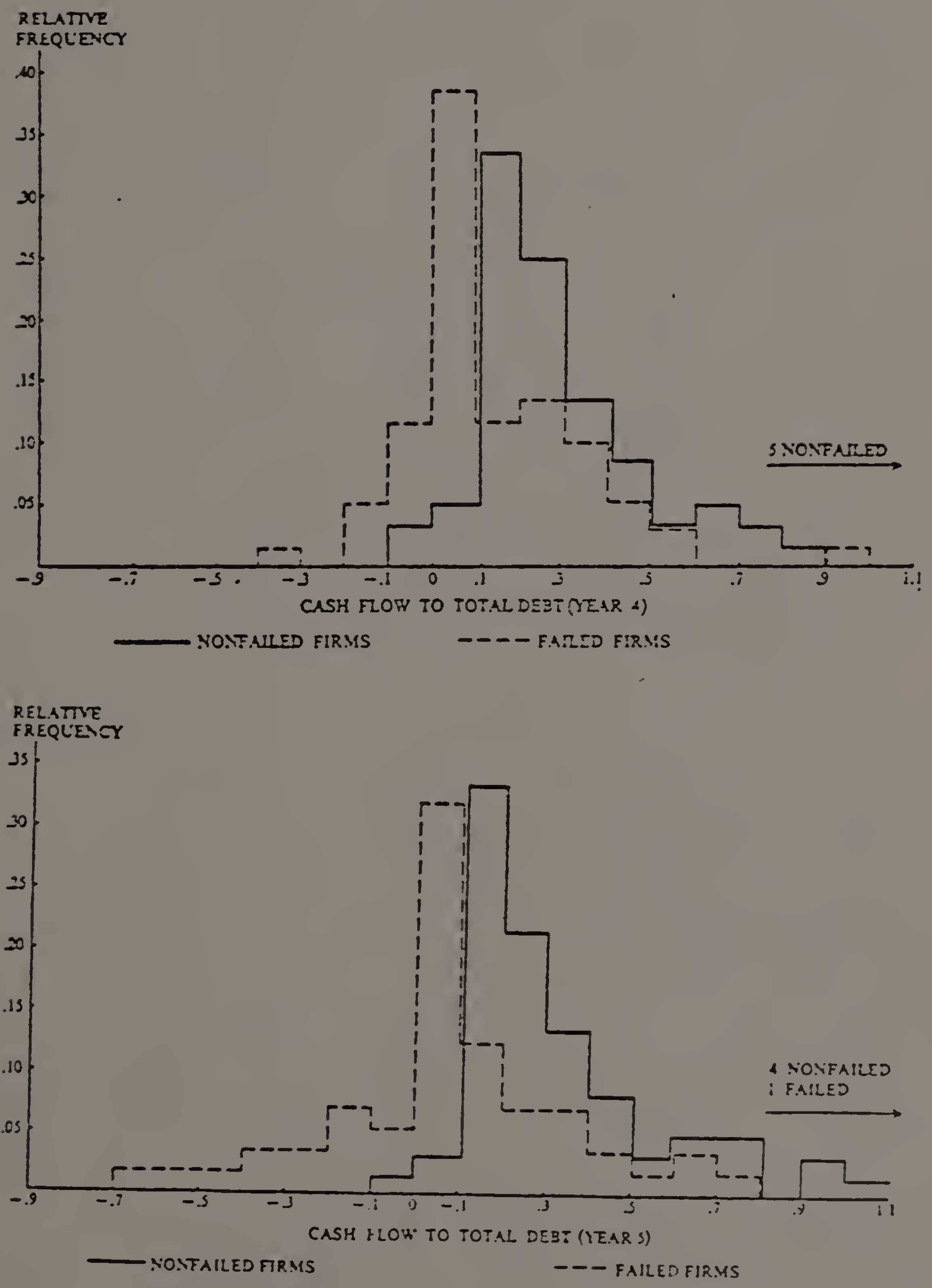


Figure 1

(continued)



Source: Beaver, "Financial Ratios as Predictors of Failure," pp.92-94.

probability that the observed numerical value of the ratio would appear if θ_i were the true state of nature. The posterior probability will be the probability of the firm failing or not failing after the financial ratio analysis, $P(\theta_i \mid d_j)$. The revision of the probabilities after viewing the financial ratio is done in accordance with Bayes' Theorem:

$$P(\theta_i \mid d_j) = \frac{P(d_j \mid \theta_i)\, P(\theta_i)}{\sum_i P(d_j \mid \theta_i)\, P(\theta_i)} = \frac{P(d_j \mid \theta_i)\, P(\theta_i)}{P(d_j)}$$

where: θ_i is the true state of nature.

d_j is the j^{th} piece of data.

$P(\theta_i)$ is the prior probability of state i.

$P(d_j)$ is the probability of datum d_j.

$P(d_j \mid \theta_i)$ is the likelihood probability.

$P(\theta_i \mid d_j)$ is the posterior probability of state i.

In many cases it is common practice to state the relationships in terms of odds rather than probabilities. Odds and probability are related. The odds $\emptyset(A)$ in favor of A are related to the probability P(A) of A and the probability 1-P(A) of not A, or $\bar{A}$ by the condition:

$$\emptyset(A)\ (1-P(A)) = P(A)$$

Odds and probability are therefore translated into each other thus:

$$\emptyset(A) = \frac{P(A)}{1-P(A)} = \frac{P(A)}{P(\bar{A})}$$

Utilizing this relationship, the odds form of Bayes' Theorem is then written as:

$$\frac{P(\theta_i \mid d_j)}{P(\bar{\theta}_i \mid d_j)} = \frac{\dfrac{P(d_j \mid \theta_i)\, P(\theta_i)}{P(d_j)}}{\dfrac{P(d_j \mid \bar{\theta}_i)\, P(\bar{\theta}_i)}{P(d_j)}}$$

$$\frac{P(\theta_i \mid d_j)}{P(\bar{\theta}_i \mid d_j)} = \frac{P(d_j \mid \theta_i)}{P(d_j \mid \bar{\theta}_i)} \times \frac{P(\theta_i)}{P(\bar{\theta}_i)}$$

This is frequently rewritten as:

$$\Omega_1 = LR \cdot \Omega_0$$

where: Ω_1 is the posterior odds ratio.

LR is the likelihood odds ratio.

Ω_0 is the prior odds ratio.

The discussion could be conducted in terms of the posterior odds ratio. However, the ratio would be largely affected by the probability of failure for a particular sample which might be different from the probability of failure for all firms in the economy. The likelihood odds ratios are unaffected by the probability of failure and therefore carry with them a degree of generality. Consider a sample whose ratio distributions accurately reflect the ratio distributions of the population. The numerical values of the likelihood ratios which came from the sample will be the same as those that apply to the population even though frequency of failure in the sample is vastly different from that of the entire population.

If the likelihood odds ratio in favor of failure is greater than one, the user of the ratio after having viewed the firm's ratio will feel that the firm is more likely to fail. The higher the likelihood odds ratio, the stronger the feeling. If the likelihood odds ratio equals one, the prior feelings of the user are unchanged after looking at the ratio. If the likelihood odds ratio is less than one, the user of the financial ratio will feel that the firm is less likely to fail, the lower the ratio, the stronger the feeling. The likelihood odds ratio is a measure of the impact or diagnosticity of ratio j, where impact refers to the amount of revision from Ω_0 to Ω_1. Diagnosticity refers to the amount of information that a particular piece of datum conveys to the user. The more information that a piece of datum conveys, the greater the impact of the information, or the greater the diagnosticity. The amount of revision stems directly from the numerical value of the likelihood odds ratio. Therefore, the information content of the ratios can be evaluated in terms of the degree to which they change the prior probabilities concerning failure.

Beaver in his 1966 study, using the histograms as estimates of the likelihood distributions found that the likelihood ratio was more useful than his dichotomous classification test. Examination of the likelihood odds ratio gave indication that the financial ratios convey information for at least five years prior to failure.[20]

Multivariate models for failure prediction. With the development of sophisticated multivariate techniques, multivariate models were developed for the prediction of business failure. Altman used a multivariate technique, multiple discriminant analysis to predict failure.[21] Multiple discriminant analysis is designed to classify an observation into one of several a priori groupings, dependent upon the observation's individual characteristics. Altman used a paired sample consisting of thirty-three pairs of manufacturing firms where industry and asset size were used as the pairing criteria. Altman developed a five variable model which, using data of one year before bankruptcy correctly classified 95 percent of the total sample. The percentage of correct classifications decreased to 72 percent when data of two years prior to bankruptcy were used. When earlier data were used, the predictive power of the model became unreliable.

Meyer and Pifer developed a linear regression model for the prediction of bank failures.[22] A paired sample was again used according to the following criteria; The paired banks were in the same city, were of approximately equal size and age, and were subject to the same regulatory requirements. The sample consisted of thirty-nine pairs of banks and achieved a prediction accuracy rate of 80 percent for one and two years before failure. For a lead time of three or more years, the model failed to discriminate between failed and solvent banks.

Behavioral studies in failure prediction. Beaver's univariate ratio analysis and the multivariate models discussed above utilized the predictability of financial data independent of human judgment. With the call by the AAA Committee on Theory Construction and Verification to place more emphasis on user reactions, researchers began investigating the human judgment aspect to accounting decision making. Libby investigated the ability of bankers to predict bankruptcy given only five financial ratios as data.[23] The five financial ratios were selected as representing five independent sources of variation from a fourteen ratio set. The ratios were selected via a factor analysis upon the fourteen ratio set. Working with a sample size of thirty matched pairs of failed and nonfailed firms, Libby presented the bankers with the five financial ratios for each firm and asked for a prediction of failure or nonfailure. The bankers were able to achieve an average prediction achievement of 74 percent. Libby used the Brunswick Lens model to construct a relationship between the environmental cues (i.e., the financial ratios), and a normative regression model developed by Libby and the decision makers model.

Kennedy investigated banker'sreaction to four financial ratios in the prediction of bankruptcy or nonbankruptcy.[24] Kennedy utilized the Bayesian model of human information processing which views failure evaluation as a probabilistic information processing problem. The assumption underlying the Bayesian human information processing model is that decision makers revise their probability judgments after viewing data in accordance with Bayes' Theorem. Through analysis of the likelihood odds ratio which was inferred from the subjects' probability responses, Kennedy examined which of the four financial ratios had the greatest impact on the bankers' judgments. Kennedy also investigated whether the financial ratios caused probability revisions in the proper direction. The subjects were presented with the financial ratios in a sequential manner and asked for a probability judgment about failure after viewing each ratio. The likelihood odds ratio was then inferred from the subjects' probability responses. Analysis of the likelihood odds ratio indicated that the equity to debt ratio had the greatest impact on the bankers' decisions.

Conclusions from the bankruptcy studies. As stated before, ratio analysis in the prediction of business failure depends upon the assumption that the ratios for failed and nonfailed firms are drawn from different ratio distributions. This appears to be the case since the studies cited above were able to develop discriminating functions that relied upon this assumption. Nonetheless, there appears to be some overlap between the distributions that makes some firms difficult to classify in advance, since none of the models developed are perfect predictors of failure. It also appears that the distributions overlap to a greater degree when the failure is further away in time since the prediction of failure was much less accurate when the data was used from three or more years prior to failure. The overlapping and temporal effects are clearly seen through Beaver's histograms presented earlier in figure 1. It also appears that decision makers are able to discriminate between the two different ratio distributions since they were able to predict failure using the financial ratios at an accuracy rate greater than that attributed to chance.

Current Cost Information and Business Failure Prediction

The financial ratios used in these predictive models and the financial ratios that were given to the decision makers were computed from financial statements that were prepared on a historical cost basis. The current replacement cost model proposed by Edwards and Bell calls for restatement of accounts to current replacement cost. Edwards and Bell specifically point out that accounting statements prepared on a current cost basis give a better indication of the long run profitability and viability of the firm. Edwards and Bell state:

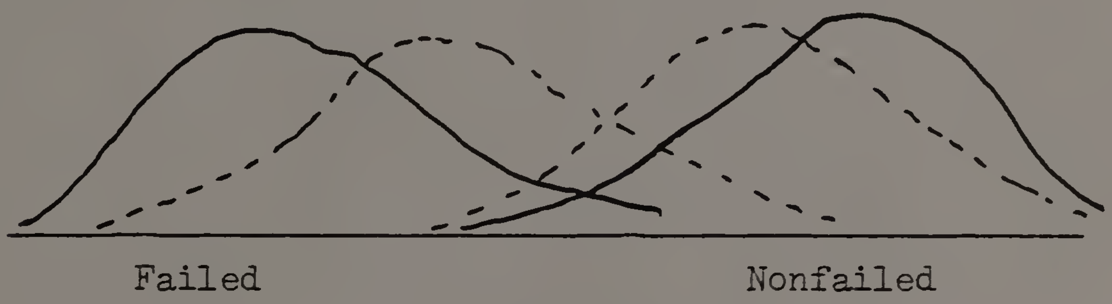
> Values based on current-cost would appear to be the best measure of the productive resources being used by the firm in its existing process of production. Current operating profit results from matching current costs with sales.
> Current operating profit is a measure of the amount of current output, in the sense of value added which is profit. It indicates the excess of the value of output sold over the resources used in producing and selling that output...
> Current operating profit, on the other hand, provides an answer to a different question. It indicates whether or not the current proceeds from the sale of product are sufficient to cover the current cost of the factors of production used in producing that product. The existence of a profit for a particular period indicates that the firm is making a positive long-run contribution to the economy... Current operating profit, therefore, is essentially the long-run profit associated with the existing process of production... In this sense current operating profit evaluates the firm as a going concern.[25]

If the contention that current cost information is more meaningful than conventional accounting reports for the evaluation of a firm as a going concern, then the current-value information must contain more information than historical cost data, i.e., current-value information will reduce the uncertainty surrounding the failure event to a greater degree than will the same piece of data presented on a historical cost basis. Since financial ratios reflect the basic dimensions of the firm and are quite useful in the prediction of business failures, it is quite probable that this additional information would carry through financial ratio analysis. This should enable models and decision makers to achieve a higher prediction accuracy using the current cost financial ratios. If current cost financial ratios are more effective at predicting business failure, private and social benefits could be derived from a change to current-value reporting. Since there is both a private and a social cost involved in business failure because of the misallocation of scarce resources, a better warning signal could result in a cost savings through a more effective and/or timely allocation of resources.

If current-value data does in fact present superior information with respect to failure prediction, it could show up in ratio analysis through one or more of the following ways. As a firm approaches failure, its deteriorating financial condition is reflected through ratio analysis by the separation of the ratio distributions for failed and nonfailed firms. Current-value distributions could be different from their historical cost counterparts which would cause different information to be conveyed to the current-value ratio user. Current-value ratios could cause the difference in the distributions for failed and nonfailed firms to increase. This is illustrated for a univariate model for any ratio in figure 2 below.

Figure 2

Possible Mean Effects of Current-Cost Information



----- Historical cost ratio distribution.

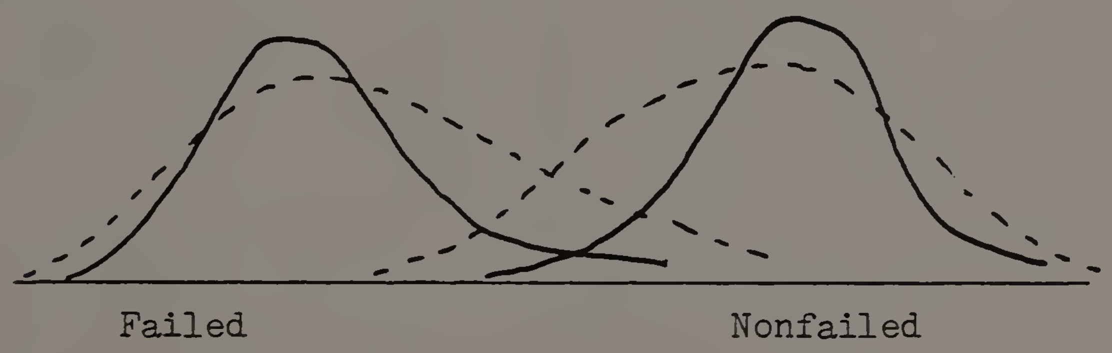
——— Current cost ratio distribution

In the current-value ratio distributions, the means are located further apart from one another and there is less overlapping of the two distributions as contrasted with the historical cost ratio distributions. If current cost information does in fact display such properties, a current cost ratio would provide more information toward ascertaining failure.

The current cost information could also result in ratio distributions with less dispersion about the mean. These tighter distributions would again result in more information being conveyed to the current cost ratio user. The two effects could also appear simultaneously, the current cost ratio distributions could be less disbursed and more separated than the historical cost ratio distributions. This is illustrated below in figure 3.

Figure 3

Possible Dispersion Effects of Current-Cost Information



----- Historical cost ratio distribution.

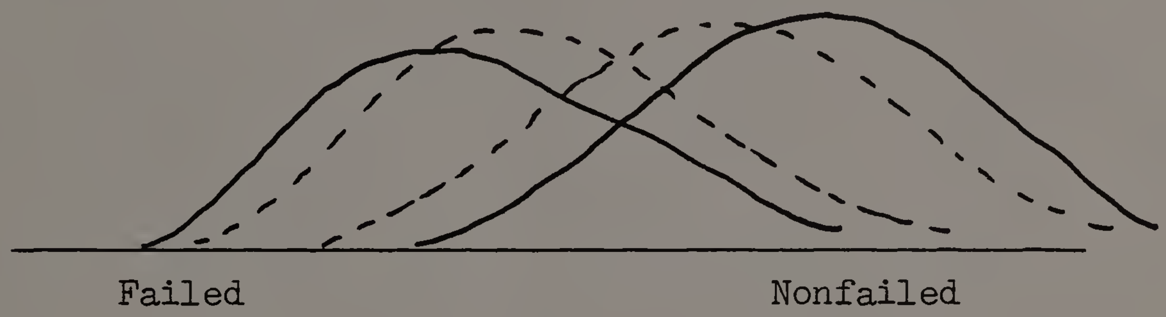
——— Current cost ratio distribution.

A third possibility is that current cost information may provide an earlier warning signal of impending failure than that provided by historical cost data. Beaver found that the failed and nonfailed distributions separated more and more as the failure came closer in time. Five years before failure the difference in the distributions was not as pronounced, making it difficult to predict failure that far in advance with any degree of accuracy. Current cost information may give an earlier warning signal of the deteriorating financial condition of the firm, which would allow decision makers to predict failure at an earlier date. This possibility is illustrated in figure 4. Notice that the temporal effects are more prevalent at an earlier date.

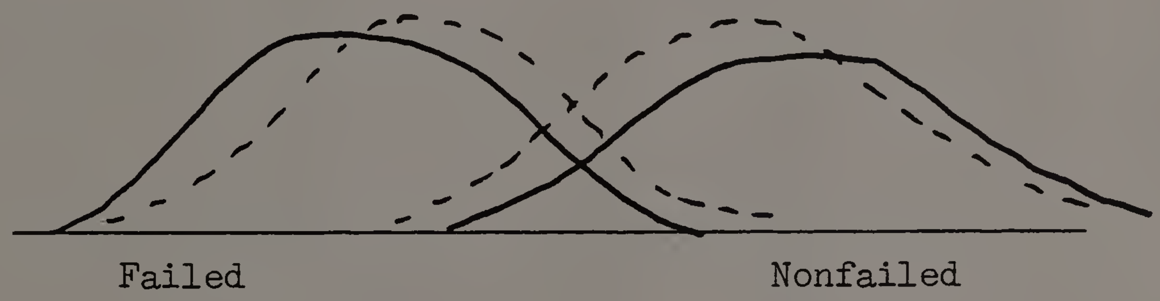
Figure 4

Temporal Effects of Current-Cost Information

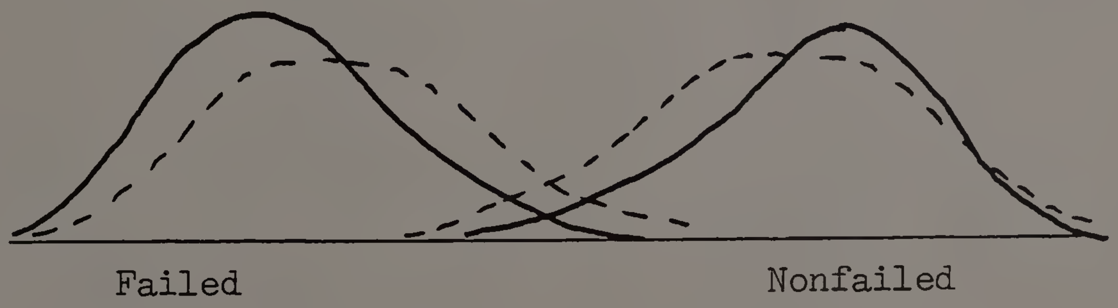
Five Years Before Failure



Three Years Before Failure



One Year Before Failure



----- Historical cost ratio distributions.

——— Current cost ratio distributions.

The Current Study

These possibilities will be investigated by testing bankers' reactions to current cost financial ratios versus historical cost financial ratios. The bankers will be asked to make subjective probability estimates that a firm will fail within the next three years after being shown ratios computed from current costs, from historical costs, and both ratios shown together. The financial ratios will be prepared from financial statements three years before the actual failure date. The process will be repeated for the time period one year before failure. The ratios for the nonfailed firms will be prepared from corresponding time periods. The dependent variable will be the subjective likelihood odds ratio of the bankers making the predictions. The likelihood odds ratio will be inferred by using Bayes' Theorem in conjunction with the bankers' responses. The likelihood odds ratio will then be tested for differences between the bankers' reactions to the three information classes (current cost alone, historical cost alone, and both current cost and historical cost together).

Investigation of the likelihood odds ratios will give an indication of how the bankers perceive the likelihood distributions for the three information classes. Differences in the likelihood odds ratios will reflect differences in the information content that the ratios from the three information classes are conveying to the ratio users. Since the ratios are being computed from a sample of actual failed and nonfailed firms, it will be possible to use the predictability criterion to select which information class represents the best information alternative for failure prediction from a decision makers point of view.

The Following Chapters

Chapter two will present a review of the replacement cost literature with a further development as to why current cost financial ratios should make better predictors of failure than historical cost ratios. Chapter three will present a review of the literature on Bayes' Theorem as a model for human information processing. Literature will be drawn from both the psychology literature and the accounting literature. The experimental design and procedures will be covered in chapter four, and analysis of the data collected in the experiment will occur in chapter five. Chapter six, the concluding chapter, will draw conclusions from the data analysis, discuss limitations of the study and suggest further areas to be explored with current cost data and the Bayesian model of human information processing.

FOOTNOTES

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[2]Accounting Standards Committee, "Proposed Statement of Standard Accounting Practice: Current Cost Accounting," Accountant, (December 1976), pp. 635-640.

[3]Anon., "Late Developments," Journal of Accountancy, (August 1977), p. 3.

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C H A P T E R I I

REVIEW OF THE CURRENT COST LITERATURE

Introduction

Dissatisfaction with conventional historical cost reported accounting data is widespread among both users and the preparers of the information as evidenced by the following remarks:

> Historical cost valuation of resources, which are most commonly available are in principle irrelevant under changed conditions.[1]

> The accounting information that the SEC requires is, on the whole, not relevant for investors. In part, this is due to the basic inability of accounting data to measure economic events effectively.[2]

A great deal of this dissatisfaction arises due to the inconsistency between the economic and accounting concepts of income and asset valuation. Because of this inconsistency, accounting information is often alleged to be of little use because it does not portray economic reality.

Economic Versus Accounting Income and Asset Valuation

The concepts of economic income believed to be of practical use emanate from the fundamental view that periodic income is the amount of wealth that a person or legal entity can consume or dispose of over the course of the period and remain as well off at the end of the period as at the beginning:

> ... it would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning.[3]

A number of serious problems are associated with this definition. Hicks pointed out that no difficulty arose in using an income concept in statics, where "a person's income can be taken without qualification as equal to his receipts." In representing a dynamic system, however, Hicks did not believe that incomes were a suitable tool for analysis because "there is too much equivocation in their meaning, equivocation which cannot be removed by the most painstaking effort." The equivocation is due to the "expect to be" part of Hick's income definition. A corporations wealth should be measured in reference to its future net earnings stream rather than by the aggregate assets value.[4] Specifically, the firm's wealth should be determined by discounting the future streams of net earnings accruing to the stockholders.

The economic definition of income as the periodic change in the discounted value of future earnings would be appropriate in a world of certainty, where future earnings and discount rates were perfectly known, however, difficulties are encountered when the certainty assumption is relaxed. In this case, future earnings and discount rates would be random variables for which at best, only their probability distributions are known. Under these circumstances, the concept of a discounted value becomes rather vague. Therefore, under real-world circumstances the economic approach to income and asset measurement is not well defined or operational.

According to Solomons, problems result from periodizing income since ultimate income is a fact.[5] Solomons reconciles accounting income with economic income as follows:

  Accounting Income
+ Unrealized tangible asset changes
- Realized tangible asset changes which occurred in prior periods
+ Changes in value of intangible assets
= Economic Income.

The current method of income determination employed by accountants is not from the discounting of future earnings, but rather the determination of income by operations. Essentially, the costs of goods and services consumed during the period are subtracted from the value of goods and services provided to yield an income figure. Accounting income is thus obtained by a process of matching costs against revenues.

Accounting income and economic income can be made congrous by redefining costs and revenues. When revenues are defined as any increase in the value of assets or a decrease in the value of liabilities, and when costs are defined as any decrease in the value of assets and increases in the value of liabilities, the difference between revenues and costs will equal economic income. When matching costs against revenues, accountants recognize only realized value changes, i.e., those changes resulting from an exchange transaction. Capital gains are ignored until they are actually realized by a sale, thus refusing to recognize changes in the value of assets as they occur. Accordingly, accounting and economic income would be equal only if the original cost of all the firm's assets not yet charged to operations equalled their market values. Periodic changes in the values of specific assets will result in differences between accounting and economic income and asset values.

The Edwards and Bell Model

Edwards and Bell have attempted to devise an accounting model that would more closely approximate economic income, the model would permit the separation of value changes into realized and unrealized changes.[6] This is a separation of business net income into two parts, one representing the current differences between costs and revenues, and the other representing holding gains and losses due to specific price changes. Their system embodied the following profit concepts:

Current Operating Profit (COP) = Profit on Operations

Business Profit = COP + Realizable cost savings.

Realized Profit = COP + Realized cost savings.

The business profit concept is based upon an application of the realization principle on a production basis and on the use of the realizable principle over time. On a production basis, values are derived from prices prevailing in those markets from which the firm gets its inputs. Entry values are used as a basis for the valuation of assets on hand, but these assets are at entry values that carry current dates; all assets are carried at current costs, but no gains from production are recognized until final sale.

Current operating profit results from matching the current costs with current values (entry with exit values):

$$\text{Current Operating Profit} = \text{Revenues} - \text{Current value of inputs contained in goods sold}$$

Each asset on the balance sheet is valued by summing the current costs of all the inputs which the firm used in bringing the asset to its present state. An increase in the current cost of assets held represents a cost savings, not a holding gain. Current operating profit measured thus, is a measure of the amount of current output which is a profit. It indicates the excess of the value of the output sold over the resources used in producing and selling that output. The values based on the current cost of inputs appear to be a better measure of the productive resources being used by the firm in its existing process of production than current accounting measures if economic income and asset valuation is used as the standard to reach. Both methods will achieve the same total income over the life of the firm, but the recognition of income will occur at different points in time.

Advantages of Current Cost Financial Statements

The information based on current costs has a number of virtues over conventional historical cost financial information. First, current operating profit represents the maximum amount of profit that can be distributed as dividends if the firm intends to continue at its current level of operations. During periods of rising prices, if disbursement was made of reported accounting income, the capital base would eventually be eroded. Current operating profit gives a much more realistic picture of distributable income.

Secondly, current cost financial statements can aid in making interfirm comparisons. Historical cost valuation hinders interfirm comparisons because financial data are dependent on the timing of asset acquisition. Under current reporting conditions, if two firms were identical in all respects except the timing of asset acquisition, the income statements and balance sheets would differ because of the differences in the original asset costs. Such differences, however, have little economic significance. These differences due to timing of asset acquisitions will disappear when current values are used, thus allowing a more meaningful interfirm comparison.

Financial statements presented on a current cost basis will give a more realistic statement of position. The assets and liabilities on the balance sheet will represent current-values determined without regard to any accounting assumptions, this also results in a more realistic statement of owners' equity. Aggregations or measures of these values will then be based on a common denominator - current prices - and will therefore be more economically meaningful than conventional balance sheet measures. The current prices of assets are of considerable importance for various purposes of financial analysis, such as liquidity evaluation where debt coverage is examined.

Since current cost financial statements will more closely approximate economic income and asset figures, economic theory of the firm can be applied more directly in the prediction of business failures for certain cases. If current operating profit is a loss, then the firm is not covering the current costs of production and economic theory would indicate that the firm should fail or move to another industry or change something in its production processes to become more efficient. Historical cost figures do not display this as clearly would the current cost figures. Since income over the life of the firm is the same in both cases, historical cost income would eventually show this happening, but there could easily be a time lag when compared with current cost financial statements. Without this time lag, current cost financial statements could easily provide an earlier warning signal than their historical cost counterparts.

Because of these virtues, current cost financial statements could provide information that will be more effective than their historical cost alternatives in the forecasting of business failures.

The financial ratio literature generally argues for ratios that are formed only from elements based on common values. Ratios prepared from historical cost financial statements are frequently in violation of this relationship because they combine values from different time periods that are not congrous. Current cost financial ratios will be based on a common denominator - current prices - and should therefore be more meaningful and useful than historical cost financial ratios.

Literature Review of Current Cost Studies

There has not been a great deal of empirical research in the current cost area. Most of the literature contains armchair reasoning as to the pros and cons of current-value reporting. Since current cost reporting was not mandatory, except until recently for a few firms, the lack of available current cost data was one of the major hinderances to empirical research.

Descriptive studies on current costs. Early studies were of a descriptive nature, investigating the differences in reported income figures between current cost reporting and historical cost reporting. In 1954, Warner investigated the effects on income of restating historical cost depreciation to current cost depreciation.[7] Warner used a very small sample in his study, looking at only five companies for the years 1938 through 1951. In almost every case, income was significantly reduced when the switch was made to current cost depreciation. The percentage decrease in income ranged from a low of 1 percent to a high of 51 percent decrease in income during the post-war years.

Brooks and Buckmaster in 1974 also investigated the effects on income of current cost reporting.[8] In addition to restating historical cost depreciation figures, Brooks and Buckmaster made adjustments to restate cost of goods sold to current costs. Their results indicated that with few exceptions historical cost income was higher than current cost income.

The issuance of ASR/190 by the SEC in 1976 resulted in approximately 1,000 firms reporting replacement cost figures.[9] Scheiner and Morse examined the effects of this disclosure on income, asset size, and performance rankings.[10] The researchers examined 20 industries and found that in all but one industry, replacement cost income was less than historical cost income. The median difference in net income for the 20 industries was 32 percent. Most of the difference came about through the increased depreciation charges under replacement costs. There were substantial differences in net long-term assets after adjustment to replacement cost, with replacement cost figures being higher. Examination of rankings of the industries by three performance measures: return on sales, rate of return on total assets, and rate of return on stockholders' equity, indicated that industry rankings were not significantly altered. The researchers, however, did not investigate movements within an industry.

Since current-value income appears to be consistently below historical cost income, managers of failing firms could possibly be returning too much in the form of dividends, thus eroding their real capital base and causing the eventual failure of the firm. Historical cost figures would not reveal this as clearly as current cost financial statements.

Predictive studies in current cost accounting. Little research has occurred in the area of the predictive ability of current-value financial data. Frank, in 1969 investigated the relative predictive significance of current cost income and historical cost income in predicting historical cost income for the firm.[11] No attempt was made at the prediction of current cost income in the study. Frank used regression analysis and exponential smoothing models to forecast income. In general, no clear advantage seemed to exist in using current cost income as the independent variable for earnings prediction.

Buckmaster, Copeland and Dascher extended the research done by Frank by including general price level adjusted income figures in addition to historical cost and current replacement cost data in the prediction of future earnings.[12] The researchers used historical cost income to forecast historical cost income, current cost income to forecast current cost income and general price level adjusted income to predict general price level adjusted income. Their conclusion was that historical costs are the best predictor of future numbers of the same series with replacement costs a somewhat less effective predictor of itself. Caution is issued in interpreting these results, as artificial income smoothing may have occurred to the historical cost income figures which would not be the case with replacement cost income.

Behavioral studies in current cost reporting. Mc Intyre, in 1973 tested the usefulness of current cost financial statements in making investments in common stock.[13] Experimental subjects were fiven financial statements of pairs of actual companies and asked to select the firm which they felt would produce the highest rate of return over a certain holding period. Three classes of information were distributed to the subjects for each company, with each subject receiving only one class of information on one pair of companies. The classes of information presented were historical cost only, current cost only, and a combination of both. The results were then analyzed to see if subjects using current cost financial statements made different and better decisions than those using only historical cost financial statements. The study failed to show any advantage to users of current cost financial statements. The study, however, contains many serious limitations so that a conclusion that current cost financial statements would not be useful to investors would not be justified.

Conclusion

The lack of empirical research in the area of current costfinancial statements indicates that there is a strong need for research in the area to aid policy makers in the decision whether current cost financial data should be mandatory for some or all firms. There is support in the economic literature and economic theory that current cost financial data would be a better predictor of business failures than historical cost financial data. Indications that firms are currently overstating economic income through income reporting by current accounting methods also lends support to this hypothesis.

FOOTNOTES

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CHAPTER III

REVIEW OF THE PSYCHOLOGY LITERATURE

Introduction

Satisfactory decisions in an uncertain environment require sound inferences about prevailing and future states of the environments in which an enterprise operates. A great deal of effort has been invested in the development of probability theory and statistics in order to provide a set of coherent, formal procedures for making inferences in an uncertain environment. One aspect of probability theory focuses on the correct revision of probabilities in the light of new information, i.e. the problem of revising the probability of a hypothesis as a function of the occurrence of a relevant datum. This aspect revolves around the concepts of personal probabilities and Bayes' Theorem. Personal probabilities are ideally consistent opinions and conform to the axioms of probability theory. A number of investigators have used formal statistical theory as a point of reference for the study of human inference. Behavioral decision theory research consists of evaluating the extent to which inferences made by man correspond with ideally consistent behavior as outlined by statistical decision theory. Much of the psychological research has used Bayes' Theorem as a standard against which to compare actual behavior and to search for systematic deviations from optimality.

The Bayesian Model

Given several mutually exclusive and exhausting hypotheses or states of nature, Θ_j, and a datum, d_i, Bayes' Theorem states that:

$$P(\Theta_j | d_i) = \frac{P(d_i | \Theta_j)\ P(\Theta_j)}{\Sigma_j\ P(d_i | \Theta_j)\ P(\Theta_j)} = \frac{P(d_i | \Theta_j)\ P(\Theta_j)}{P(d_i)} \qquad (1)$$

In this equation, $P(\Theta_j | d_i)$ is the posterior probability that Θ_j is the true state of nature, taking into account the new datum, d_i, as well as all previous data. $P(d_i | \Theta_j)$ is the conditional probability that datum d_i would be observed if the state of nature Θ_j were the true state of nature. For a set of mutually exclusive and exhaustive set of hypotheses, the values of $P(d_i | \Theta_j)$ represent the impact of datum d_i on each of the hypotheses. $P(\Theta_j)$ is the prior probability of the state of nature Θ_j.

In the Bayesian human information processing literature, information processing is conceptualized as a sequential process where each datum d_i is evaluated in term, resulting in a revision of the perceived probabilities of future events. Subjects in Bayesian experiments are first required to generate a probability distribution over a number of prespecified values or categories of Θ_j. This initial (prior) distribution reflects all previously known information and is prior to any new information provided by the experimenter. Data are then provided to the subjects, and the subjects are asked to provide estimates of the posterior probabilities in light of the additional information. The data conditional posterior assessments generated as a result of the subjects' usage of a cognitive heuristic based on the inconclusive data should be consistent with Bayes' Theorem if man is a Bayesian information processor. This has been the major research question in several studies.

The subjective probability distribution approach offers the likelihood measure, $P(d_i|\theta_j)$, as an indication of the relevance or impact that a particular piece of datum d_i has for changing the prior $P(\theta_j)$ to the posterior $P(\theta_j|d_i)$ for event j. Frequently θ_j is held as a dichotomous classification of the possible states of nature. To directly compare the relative likelihood of events θ_j and $\bar{\theta}_j$ and the data diagnosticity of datum d_i, the odds form of Bayes' Theorem is frequently used. The odds form of Bayes' Theorem is simply the ratio of Bayes' Theorem for two events θ_j and $\bar{\theta}_j$:

$$\frac{P(\theta_j|d_i)}{P(\bar{\theta}_j|d_i)} = \frac{P(d_i|\theta_j)}{P(d_i|\bar{\theta}_j)} \cdot \frac{P(\theta_j)}{P(\bar{\theta}_j)} \qquad (2)$$

or

$$\Omega_1 = LR_i \cdot \Omega_0 \qquad (3)$$

where Ω_0 represents the prior odds for events θ_j and $\bar{\theta}_j$, Ω_1 represents the posterior odds and LR_i is the likelihood ratio for the realization of the ith information variable for the two judgment events θ_j and $\bar{\theta}_j$.

Bayes' Theorem can be used sequentially to measure the impact of several data. The posterior probability computed for the first datum is used as the prior probability when processing the impact of the second datum, and so on. The order in which data are processed makes no difference to their impact on posterior opinion. When realizations from I information variables are made available, the final posterior odds are:

$$\Omega_n = \prod_{i=1}^{n} LR_i \cdot \Omega_0 \tag{4}$$

Equation (4) shows that data affect the final odds multiplicatively. Each Ω_n is a function of the prior odds, and therefore all previously available information, and the specific data realizations for each of the I information sources.

Knowledge of the likelihood ratio yields information as to how a subject perceives the uncertainty in his/her environment and how relevant a particular piece of datum d_i is to the reduction of uncertainty. In order to estimate the likelihood ratio in an experimental situation, researchers generally test for the prior odds, introduce a piece of datum d_i, and then test for the posterior odds. Given the posterior and prior odds, the likelihood ratio can then be inferred from equation (3). The odds in favor of Θ_j and $\bar{\Theta}_j$ are revised from Ω_0 to Ω_1 as a result of datum d_i. The likelihood ratio is a measure of the impact or diagnosticity of datum d_i, where impact refers to the amount of revision for Ω_0 to Ω_1. Diagnosticity refers to the amount of information that a particular d_i conveys to the user. The more information that a particular datum d_i conveys, the greater the impact of the information, or the greater the diagnosticity. The amount of revision stems directly from the numerical value of the likelihood ratio. If $LR_i = 1$, there will be no information content in datum d_i since the datum d_i was viewed as being equally probable under both hypotheses Θ_j and $\bar{\Theta}_j$. The posterior odds will not be different from the prior odds after viewing this particular piece of datum. When the likelihood ratio is greater than one for a particular datum, the posterior odds in favor of $\bar{\Theta}_j$ will increase upon realization of this particular datum. If the likelihood ratio is less than one for a particular datum, then the posterior odds in favor of $\bar{\Theta}_j$ will decrease, thus increasing the odds in favor of $\bar{\Theta}_j$. Given a state of nature $\bar{\Theta}_j$, the greater the probability of obtaining a particular datum d_i, $P(d_i|\bar{\Theta}_j)$, the more information that this piece of data conveys to the recipient. Therefore, the greater the distance that the likelihood ratio is from one, the greater the impact the likelihood ratio has on the posterior odds.

The use of Bayes' Theorem assumes that data are conditionally independent, i.e.:

$$P(d_i|\Theta_j) = P(d_i|\Theta_j,d_k) \qquad i \neq k \tag{5}$$

If the probability of observing a particular datum d_i is dependent upon what has been observed for a previous d_i, i.e.:

$$P(d_i|\Theta_j) \neq P(d_i|\Theta_j,d_k) \qquad i \neq k \tag{6}$$

then equation (1) must be rewritten to reflect this conditional data dependence. For two data, the appropriate revision is:

$$P(\Theta_j|d_1,d_2) = \frac{P(d_2|\Theta_j,d_1)\ P(\Theta_j|d_1)}{\Sigma_j\ P(d_2|\Theta_j,d_1)\ P(\Theta_j|d_1)} \tag{7}$$

As more data are received, the equation requires further expansion and becomes difficult to implement.

In terms of empirical research, psychologists have concentrated on generation of prior and posterior probabilities with emphasis on properties of data sets, revision of probabilities relative to Bayes' Theorem, simultaneous versus sequential presentation of data, and the internal consistency of subjective probability estimates. Recent work in the area is process oriented with explanations of results being suggested in terms of cognitive heuristics and biases.

Review of the Psychology Literature on Probabilistic Judgments

Initial research on subjective probabilities emphasized the internal consistency of probability assessments. Probabalistic consistency refers to the degree to which a person's inferences correspond to the relationships specified by probability theory. Although the evidence is mixed, it appears that subjects do generally provide probability assessments that follow the relationships described by probability theory. Edwards, Lindman and Phillips demonstrated that subjects provide assessments of prior and posterior distributions which sum to one.[1] Peterson, et al. examined the veridicality and internal consistency of subjective probabilities in an experiment using naturalistic events with unknown objective probabilities, and events with experimentally determined probabilities.[2] Peterson, et al. concluded that the results of their experiments indicated that a set of subjective probabilities forms an integrated system. Departure from veridicality in one part of the system implies compensatory departure in other parts. Individual probability estimates reflect an underlying network of probability relationships and are thus interdependent. Wyer, in 1970, performed experiments which supported the notion that subjective probabilities follow the laws of objective probabilities, and are thus internally consistent.[3]

Winkler and Murphy, in defining what makes a good probability assessor have made useful distinction between two dimensions of expertise.[4] First, "substantive" goodness refers to a knowledge which the assessor has concerning the subject matter of concern; second, "normative" goodness is the ability of the assessor to express his opinions in probabilistic form. As will become evident, this distinction between the substantive and normative dimensions of goodness is useful for interpreting the literature.

In an experiment involving the prediction of daily temperatures by two experienced meteorologists, Peterson, et al. found that the meteorologists were able to quite accurately assess the probability distributions.[5] In another study, Murphy and Winkler using meteorologists achieved similar results of goodness.[6] It is quite obvious that the meteorologists possessed "substantive" goodness and were quite well suited for the task of temperature prediction.

Peterson and Beach describe experiments in which subjects are asked to estimate means, variances, correlation coefficients, and other statistical properties of probability distributions.[7] The experimental evidence indicates that subjects are capable of accurately estimating many of these statistical properties intuitively.

A Major amount of psychological research has focused on subjective probability revision relative to Bayes' Theorem. A large number of studies have shown that Bayes' Theorem is a reasonably good model of human information processing. Revisions tend to be probabalistically consistent and people tend to make revisions in an orderly fashion as a result of new information. Despite this internal consistency found in subjective probabilities, many researchers have found that subjects are conservative in their probability revisions. Upon receipt of new information, subjects revise their posterior probability estimates in the same direction as that specified by Bayes' Theorem, but the revision is typically too small; subjects act as if the data are less diagnostic than they truly are. Edwards, in labeling this trait conservatism comments: "opinion change is very orderly, and usually proportional to numbers calculated from Bayes' Theorem,...it is insufficient in amount."[8]

Much of the Bayesian research has been focused on discovering the determinants of conservatism. Three generalized explanations for conservatism have been generated. They are misperception, misaggregation, and artifact hypotheses. Subjects must have some understanding of the data generator, model, etc., used by the experimenter in order to accurately assess the conditional environmental distribution $P(d_i|\theta_j)$. It has been demonstrated that subjects frequently misperceive the data generating device. If such misperceptions are the cause of conservatism, then one would expect estimates of posterior probabilities to be consistent with the subjective estimates rather than the objective probabilities. Peterson, DuCharme, and Edwards found this to be the case, they found that subjects' conservative $P(\theta_j|d_i)$ estimates could be explained by the deviations of their $P(d_i|\theta_j)$ estimates from their true values.[9] Persons with "substantive" goodness would be expected to provide more accurate estimates of $P(d_i|\theta_j)$ and their revisions would be more in agreement with the revisions specified by Bayes' Theorem than a naive assessor.

The misperception of the conditional distribution is highly likely for extremely unlikely events, it has been suggested that unlikely events, when they occur, are seen as uninformative.[10]

Conservatism may be a result of peoples' inability to aggregate the diagnostic impact of multiple data received simultaneously, i.e. people do not combine likelihood ratios very well.

The third explanation of conservatism, the artifactual hypothesis, was suggested by Peterson and DuCharme.[11] This is a form of response bias that explains conservatism in that subjects exhibit conservatism only for very extreme posterior odds, i.e. a ceiling/floor effect biases probability responses in that people are unwilling to indicate extremely high or low assessments.

Conservatism is not a universal phenomenon. When the environment faced by the subjects becomes more complex, and specifically, when the data, which are displayed sequentially, are neither conditionally independent nor reliable, the subjects do not necessarily display traits of conservatism.[12]

Several studies have indicated that a primacy effect may be present in sequential data processing. Peterson and DuCharme,[13] and Dale,[14] reported primacy effects. Primacy refers to the situation where subjects are influenced so strongly by the earlier information in a sequential presentation of information, that when later, contradictory information is presented, the subjects fail to adjust their probability judgments in the proper direction. A contrary finding has also been reported known as a recency effect. In the recency effect, subjects are influenced more heavily by the later data messages, even if the earlier messages were contradictory in nature. Pitz, Downing and Reinhold,[15] and Shanteau[16] have reported recency effects in sequential processing of information.

Despite evidence which indicates that people do not always process information in the manner specified by Bayes' Theorem, many researchers feel that the Bayesian model provides a fairly accurate description of actual inference processes. Edwards makes this comment: "But, from my point of view, the astonishing fact is not that people do not hit Bayes on the third significant figure, but rather that they behave in a sufficiently orderly way, faced with an extremely difficult intellectual task, so that Bayes can be used as a first approximation to the observed behavior."[17]

Not all research points to man as a rational intuitive statistician, in fact, many researchers feel that man is not a Bayesian information processor at all. Hogarth argues that man is ill suited for the task of information processing: "In summary, man is a selective, stepwise information processing system with limited capacity, and as I shall argue, he is ill equipped for assessing subjective probability distributions."[18]

Kahneman and Tversky recently started investigating the question, "How do people evaluate uncertainty?" rather than "How well do people evaluate uncertainty?" They report that humans react to their limited information processing capacity by using simplifying heuristics resulting in non-Bayesian probability estimates. They comment on mans' non-Bayesian capabilities: "in his evaluation of evidence, man is apparently not a conservative Bayesian: he is not Bayesian at all."[19]

Tversky and Kahneman identify three principles humans might use to reduce the complex tasks of assessing subjective probabilities and predicting values to simpler judgmental operations. They identify:[20] (1) Representativeness - the degree to which an event is judged similar in essential characteristics to its parent population and judged to reflect the salient features of the process by which it is generated; (2) availability - the ease with which relevant instances or examples or plausible occurrences can be brought to mind; and (3) anchoring - the process of adjusting from initial values or starting points to yield final estimates. Using 15-18 year-olds and undergraduates, Kahneman and Tversky demonstrated that subjects did not respond to prior probabilities, sample size and intercorrelation of input variables in the manner specified by Bayes' Theorem. All three of these factors should affect judgments of subjective probability, but did not do so due to the heuristics discussed above. Kahneman and Tversky concluded that even though these heuristic principles are quite useful, they can lead to serious and systematic errors: "In making predictions and judgments under uncertainty, people do not appear to follow the calculus of chance or the statistical theory of prediction. Instead they rely on a limited number of heuristics which sometimes yield reasonable judgments and sometimes lead to severe and systematic errors."[21]

It is doubtful, however, that the subjects possessed the "normative" expertise to make good probability assessors, or the "substantive" goodness either.

Swieringa, et al. focus on the possible use of the representativeness heuristic in making judgments of subjective probabilities.[22] They replicate and extend some of the Tversky and Kahneman experiments to a general business context and alternative methods of posing questions. Using graduate business students and statistics and behavioral undergraduate students, they performed five experiments testing the effects of the diagnosticity of information, operationalized as prior probabilities and sample size, on judgments of likelihoods. A sixth experiment examined the effect of correlated input variables and consistency and confidence. In general, the replications tended to confirm the results reported by Tversky and Kahneman on the representativeness heuristic. However, in some cases, the subjects in the Swieringa, et al. study outperformed the Tversky and Kahneman subjects. Significant variations in the magnitude of the effect depending upon how the questions were posed and the particular judgment context suggest that representativeness may be a contingent rather than a general method of information processing. Although this research tends to generally support the Tversky and Kahneman experiments, Swieringa, et al. do not draw the same conclusions as to mans' ability to act as a Bayesian information processor: "In our view, people's use of the representativeness heuristic may represent a simplification of, rather than a departure from, the normative Bayesian approach."[23]

Appropriateness of the Bayesian Model to This Project

It is difficult to assess mans' ability to act as a Bayesian information processor since most studies have involved subjects who cannot be described as either substantive nor normative experts. This makes extrapolation to mans' abilities in a complex realistic setting difficult. It seems safe, however, to draw the conclusion that substantial experts can make meaningful assessments that are consistent within their belief structure in situations with which they are somewhat familiar and have had feedback on past performance.

The Bayesian model of human information processing possesses considerable intuitive appeal given this particular decision setting and the subjects involved. The purpose of the study is to examine the diagnosticity and direction of impact that the alternative information systems provide for the assessment of business failures. Libby and Lewis comment upon the appropriateness of the Bayesian model in looking at diagnosticity and predictive significance: "This method (Bayesian) is especially well suited for examining the impact of information set variables, e.g. aggregation and alternative information structures, and variables characterizing both the decision maker and the decision rule. Where criteria already exist, Kennedy has shown the utility of Bayes' Theorem as a descriptive model of cue usage and predictive significance."[24]

The loan officers used as subjects in this study appear to be well qualified as substantial experts in the area of financial ratio analysis. Therefore, given that individuals are frequently consistent in their probability revisions given their subjective distributions, it is expected the Bayesian model will provide reasonable estimates of the subjects subjective likelihood distributions by inference from their prior and posterior assessments concerning failure. The inferred subjective likelihood distributions from these substantive experts should reflect the relative diagnosticity and predictive significance of the alternative information systems.

Although the subjective distributions will not necessarily be veridical, i.e. correspond directly to the objective probabilities, knowledge of how the subjects perceived the distributions for the different information classes will give considerable insight into how the alternative information systems could affect decisions.

Bayesian Human Information Processing Studies in Accounting

Ronen reported the results of a lab experiment designed to test the consequence of a decision to report joint probabilities in aggregate form versus reporting individual probabilities in disaggregated form.[25] He studied whether decision makers would be indifferent between events with expected values that were equal (equal joint probabilities) but which had differing sequences of marginal probabilities. Although the task was nonaccounting in nature, Ronen related the experiment to decision makers' abilities to use probabilistic reports to make capital budgeting decisions.[26] Using graduate business students as subjects, he reported that with equal joint probabilities in a decision, the subjects displayed a significant preference for the sequence with the higher probability of initial success. Formal decision theory indicates that the decision maker should be indifferent between the choices since they have equal expected values. In other decisions, predetermined differences existed in the joint probabilities. When the joint probabilities were not equal, the results indicated that when the differences between the expected values are small enough, subjects preferred the lower expected value sequences, provided that their initial probability of success is higher. However, when the discrepancy between the expected values became large, the subjects acted in a rational manner as specified by formal decision theory.

Barefield studied the impact of aggregating cost variances on process control judgments.[27] Using findings in the Bayesian literature, Barefield formulated the hypothesis that subjects would perform better with aggregated data than with the sequential presentation of disaggregated data. The hypothesis was constructed on the basis of prior research studying the effect on conservatism of sequential data presentation and the number of data items. The impact of presenting two separate cost variances or a combined cost variance in the judgment of labor efficiency was the focus of the study. Using students as subjects, he presented the subjects with one of three information conditions. Subjects were presented with a single combined variance or they were provided with two variances that differed in the level of cue redundancy. Using discriminant analysis, Barefield modeled the judgments of his subjects to estimate their accuracy and consistency. He concluded that neither the number of cues nor redundancy had an overall significant effect on performance measured by the departure from optimal performance as determined by Bayes' Theorem. However, subjects receiving the disaggregated data performed slightly better than subjects receiving aggregated data.

Dickhaut examined the possible effects of the dual presentation of alternative information systems.[28] He used the average absolute difference between subjects' probability estimates and the optimal Bayesian probability estimate as the dependent measure in an experiment designed to consider the possible advantage/disadvantage of resolving the problem of choosing between alternative information systems by presenting both systems. Using undergraduate business students and businessmen as subjects, Dickhaut had the subjects estimate the probability that an object is a member of one of two mutually exclusive states of nature. Probability estimates were based on a message which an information system associated with that object. The accounting information systems were historical cost and current cost financial statements for hypothetical firms. In the single information system, a simplified historical cost system associated a single profit figure for each business. In the joint information system, a combination of the simplified historical cost system and a simplified current cost system associated two profit figures with each hypothetical business. Subjects were asked to estimate the probability that the firm belonged to a subset of firms which had incurred stock market price increases or decreases. Dickhaut also used cubes with different colored sides in a similar experimental design. Drawing from the literature on the concept of information reduction, Dickhaut hypothesized that subjects would perform better with the single information system than with the joint information system because the joint information system requires a greater amount of information reduction and hence is a more difficult task. Dickhaut also hypothesized that the businessmen would do better with the stock market setting and the undergraduate students would do better with the cubes and algebraic identities. The results indicated that the single information system did produce higher performance, but as suggested, the type of subject and experimental setting interacted in their effect on performance.

Kennedy used Bayes' Theorem in a descriptive role to measure data diagnosticity in loan officers' predictions of bankruptcy from asset size and four financial ratios.[29] Using a sample of failed and nonfailed firms, Kennedy had loan officers sequentially examine the asset size and the four financial ratios for each of the firms. After viewing each piece of data, the subjects were asked to estimate the probability that the firm would fail the next year. Since the ratios were not conditionally independent, Kennedy randomized the order of presentation of the ratios within and across subjects. Using the odds form of Bayes' Theorem as a model of human information processing, Kennedy inferred the subjects' likelihood ratios for each piece of data. The likelihood ratios were used as measures of the diagnosticity contained in the four financial ratios. The accuracy of the direction of impact was also examined by comparing the revisions to the actual outcome of the firm, i.e. failed or nonfailed. All four financial ratios had a statistically significant impact, with the debt to equity ratio having the greatest positive effect on the loan officers' probability estimates. Examination of the likelihood ratios indicated that the financial ratios showed high diagnosticity at extreme values.

Conclusion

Although there is mixed support of man as a Bayesian information processor, the intuitive appeal of the model for the experimental setting and the subjects used indicate that the model will be quite useful for assessing the relative data diagnosticity and relative predictive significance of the alternative information systems, historical cost and current cost financial ratios. Little work has been done in accounting utilizing the model as a description of man and his information processing behavior. Use of the Bayesian model will provide considerable insight into how people react to differing accounting alternatives in a decision setting.

FOOTNOTES

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CHAPTER IV

RESEARCH METHODOLOGY

Introduction

Bayes ' Theorem was used to study the effects of alternative accounting measurement bases as reflected through four financial ratios on the subjective probability judgments of a sample of bankers. Bankers were presented with three classes of information with five items of information, total asset size and four financial ratios in each class of information, about each of six business firms. The classes of information differ with respect to the measurement base employed in arriving at the accounting data used in the computation of the five pieces of information. The three classes of information are:

(1) Historical cost financial information.

(2) Current-cost financial information.

(3) Both historical cost and current-cost information.

Within each class of information, the following pieces of data were included:

(1) The measurement base of the accounting data employed in computing the pieces of information.

(2) Total asset size of the firm.

(3) Four financial ratios prepared from the firm's financial statements.

The class I information contained the asset size and the four financial ratios which were prepared from historical cost financial statements. Class II information contained the asset size and the four financial ratios for the same firms prepared from financial statements which were prepared on a current-cost basis. Class III information contained two measures for asset size and each of the four financial ratios. The data was presented from financial statements prepared on a historical cost basis and from financial statements that were prepared on a current-cost basis. The pieces of data disclosed which measurement base was used in arriving at the numerical value of the piece of information.

The pieces of information for each firm were computed from financial statements from two time periods. The time periods were one year before the failed firms became bankrupt and three years prior to the failed firms bankruptcy. Therefore, each of the six firms had data presented about it six times, two years of data and three classes of information for each year. For each item of information the bankers were asked for their judgment of the probability that the firm would become bankrupt over the appropriate time span.

Sample of Business Firms

The sample of business firms consisted of six companies, three bankrupt firms and three nonbankrupt firms. Only six firms were used because of the time constraint on the participants. The companies were selected from the Disclosure Journal of Corporate Events.[1]

The six firms were selected on the basis of the following criteria: (1) The firms had to meet the definition of failure used in the study. Failed firms were considered as such if they had filed for bankruptcy proceedings under the National Bankruptcy Act. (2) All six firms were confined to one industry. The industry selected was the electronic component and equipment manufacturing industry. Interpretation of financial ratios is contingent upon the industry in which the firm operates.[2] By making this a constraint, the participants did not have to make adjustments in their responses for industry effects. (3) The firms were matched on total asset size. This paired sample design reflects the view that the interpretation of the value of a financial ratio is also contingent upon the total asset size of a firm.[3] Since firms that have equal asset size under historical costs will probably not have equal asset size after conversion to current-costs, the difficulty involved in matching asset size on both measurement bases necessitated a matching of total asset size on only one of the bases. Therefore, firms were matched on asset size on a historical cost basis and no attempt was made to match asset sizes on a current-cost basis. (4) The availability of the information required to make the conversion from historical cost to current-cost financial statements via specific price indices. Information was needed to make the conversions that could be found on a firm's 10-K report to the SEC. Therefore, all firms selected were firms that filed with the SEC.

The six firms used in the study were finally selected by locating firms in the electronic component and equipment manufacturing industry that were reported in the Disclosure Journal of Corporate Events as having filed for bankruptcy proceedings. The nonbankrupt mates were selected by going through the Disclosure Journal under electronic component and equipment manufacturing and selecting nonbankrupt firms of similar asset size as the previously selected bankrupt firms.

This process resulted in the sample of failed and nonfailed firms used in the study. The sample of failed firms and their non-failed mates is presented below in table 1.

Table 1.

Sample of Failed and Nonfailed Firms

Bankrupt Firms	Nonbankrupt Mate
(1) Magnetic Head Corp.	(2) Birtcher Corp.
(3) Redcor Corp.	(4) Premier Microwave Corp.
(5) Trio Laboratories, Inc.	(6) Electronic Microsystems, Inc.

Selection of Financial Ratios

In selecting the four financial ratios used in the study, three factors were considered. The ratios should first of all reflect different dimensions of the firm. Secondly, the ratios should be used by the bankers in their work so that the bankers are familiar with the ratios and the interpretation of their numerical values. Finally, the ratios should be useful in the prediction of bankruptcy.

The four financial ratios used in the study were: (1) Net Income/ Total Assets, (2) Owner's Equity / Total Debt, (3) Current Assets / Total Assets, and (4) Current Assets / Current Liabilities. These ratios represent the following four dimensions of the firm: (1) Profitability, (2) Bank's share of the risk, (3) Asset balance, and (4) Tentative solvency. These ratios have been used in numerous predictive studies on bankruptcy,[4,5,6] and appear to have a great deal of information content for predicting business failures. At the same time these ratios also appear to be ratios that are familiar to bankers.[7]

Only four financial ratios were used because of the possible order effects in a sequence of Bayesian probability revisions, and due to the time constraint of the participants. The order effect could be a primacy or a recency effect. The primacy effect refers to the finding that information which occurs early in a sequence influences probability revisions more than later information even though the information may be contradictory.[8] The recency effect refers to the situation when later information influences revisions more than earlier information even though it may be contradictory in nature.[9] To control for an order effect with the four financial ratios, all possible permutations were used in the sequence order of information presentation to the subjects.

Data Used in the Financial Ratios

In order to test the relative information content of the three measurement classes over time, the participants were given financial ratios computed from financial statements for the time periods one year prior to bankruptcy and three years prior to bankruptcy. For the bankrupt firms, the year prior to bankruptcy was the most recent fiscal year ending prior to bankruptcy. Financial statements two years prior to those used as one year prior to bankruptcy were used as the financial statements for three year before bankruptcy. For the nonbankrupt mate, the fiscal years ending closest to that of the bankrupt firm were used.

The historical cost asset sizes and the numerical values of the financial ratios were computed from the firm's financial statements reported in their form 10-K to the SEC. Actual current-cost information was not available for the companies used in the study, so approximations were used for the current-cost data. A similar procedure to those used by McIntyre[10] and Brooks and Buckmaster[11] were used in the study. Ending balances of fixed assets and annual capital expenditures were obtained from the firm's 10-K report. Using a FIFO assumption for retirements, an aged schedule of fixed assets was constructed for each company. Using the Implicit Price Deflator for property, plant and equipment, an estimate was made of the current cost of property, plant and equipment and annual depreciation expense.

Inventories and cost of goods sold were adjusted to current costs through the use of the Wholesale Commodity Price Index for electronic equipment and components. (The reader is referred to Appendix A for a more detailed explanation of the conversion procedures employed in arriving at the current-cost figures).

The current-cost figures were then substituted for their historical cost counterparts to arrive at the current-cost financial statements. The numerical value of the current-cost financial ratios were then computed from the firms current-cost financial statements. The firms, their total asset size and their financial ratios on both historical cost and current cost for one year prior to bankruptcy and three years prior to bankruptcy are presented in tables 2 and 3.

Control and Randomization of the Sequence of Information Presentation

In order to control for an order effect in the presentation of the information, four different sequences of measurement base and time period combinations were used. It was possible that learning may have occurred in the task so that if all the participants had received the historical cost data first, a bias due to learning could have developed. Accordingly, the following sequences of information presentation were used: (1) Historical cost - three years prior to bankruptcy, one year prior to bankruptcy, current-cost - three years prior to bankruptcy, one year prior to bankruptcy, both historical cost and current-cost- three years prior to bankruptcy, one year prior to bankruptcy, (2) Current-cost - three years prior to bankruptcy, one year prior to bankruptcy, historical cost - three years prior to bankruptcy, both historical cost and current-cost - three years prior to bankruptcy, one year prior to bankruptcy, (3) Historical cost - one year prior to bankruptcy, three years prior to bankruptcy,

Table 2

The Firms and Their Financial Ratios

One Year Prior to Bankruptcy

Firm Number*	FIRM NAME INFORMATION CLASS	ASSET SIZE	FINANCIAL RATIO: Owner's Equity/Total Debt	Net Income/Total Assets	Current Assets/Total Assets	Current Assets/Current Liabilities
1	Magnetic Head Corp.					
	Historical cost	$ 2,688,275	.31	.011	.604	2.39
	Current-cost	2,873,850	.10	-.007	.565	2.39
2	Birtcher Corp.					
	Historical cost	2,005,885	.93	-.089	.736	1.99
	Current-cost	2,135,805	.79	-.051	.692	1.99
3	Redcor Corp.					
	Historical cost	1,656,000	1.34	.090	.857	2.14
	Current-cost	1,678,400	.44	.030	.846	2.15
4	Premier Microwave					
	Historical cost	1,312,300	14.64	.032	.835	14.17
	Current-cost	1,362,310	13.40	.020	.805	14.19
5	Trio Laboratories					
	Historical cost	1,708,892	.18	.002	.838	1.22
	Current-cost	1,743,600	.09	-.031	.828	1.23
6	Electronic Microsystems					
	Historical cost	508,209	2.13	.128	.688	5.56
	Current-cost	519,093	1.74	.118	.675	5.57

*Odd numbered firms are the bankrupt firms.

Table 3

The Firms and Their Financial Ratios
Three Years Prior to Bankruptcy

			FINANCIAL RATIO			
Firm Number *	FIRM NAME INFORMATION CLASS	ASSET SIZE	Owner's Equity/Total Debt	Net Income/Total Assets	Current Assets/Total Assets	Current Assets/Current Liabilities
1	Magnetic Head Corp					
	Historical cost	$ 3,451,245	.72	-.098	.373	.89
	Current-cost	3,590,120	.62	-.131	.361	.89
2	Birtcher Corp.					
	Historical cost	3,182,138	.91	.292	.705	1.66
	Current-cost	3,331,540	.83	.255	.679	1.68
3	Redcor Corp.					
	Historical cost	12,662,000	.46	-.315	.871	1.37
	Current-cost	12,932,320	.41	-.402	.867	1.40
4	Premier Microwave					
	Historical cost	1,259,200	11.85	.050	.789	12.11
	Current-cost	1,298,160	11.11	.037	.767	12.87
5	Trio Laboratories					
	Historical cost	1,125,096	.83	-.060	.744	1.68
	Current-cost	1,570,850	.72	-.086	.720	1.67
6	Electronic Microsystem					
	Historical cost	389,100	1.46	.220	.734	2.10
	Current-cost	537,198	1.17	.208	.729	2.12

*Odd numbered firms are the bankrupt firms.

current-cost - one year prior to bankruptcy, three years prior to bankruptcy, both historical cost and current-cost - one year prior to bankruptcy, three years prior to bankruptcy, (4) Current-cost - one year prior to bankruptcy, three years prior to bankruptcy, historical cost - one year prior to bankruptcy, three years prior to bankruptcy, both historical cost and current-cost - one year prior to bankruptcy, three years prior to bankruptcy. Twenty-four subjects completed and returned the questionnaire, six subjects were in each of the four information sequences.

Within this sequence structure, both the firms and the financial ratios were presented to the participants in random order. There can exist an order effect in a sequence of Bayesian probability revisions. Peterson and DuCharme reported a primacy effect in the presentation of data. The primacy effect occurs when the information that is presented earliest affects the probability revisions so strongly that when later, contradictory information is received, the subjects fail to revise their probability estimates in concordance with the additional information. Pitz and Reinhold on the other hand reported a recency effect in their research on sequential probability revisions. Recency refers to the finding that the later information influences the revisions more than the earlier information, even though they may be contradictory in nature.

Bayes' Theorem assumes that the items of information are independent. With items of information that are dependent, the likelihood odds ratio may be affected by knowledge of a correlated item.[12, 13]

Financial ratios are known to be correlated.[14] Since the information being generated by the alternative information classes is being given to the users in the form of financial ratios, and the usefulness of the different measurement bases is being measured through the likelihood odds ratio, one would like to remove the effects of the correlated ratios. This was not possible, but the impact of the correlations is being minimized by the randomization of the presentation of the ratios to the participants.

To control for the order effect which could lead to a primacy or recency effect, and to attempt to counterbalance the effects of the correlated financial ratios, the firms and the financial ratios were randomized as to the order of their presentation to the subjects.

The Participants

Twenty-four experienced loan officers and credit analysts from the larger commercial banks in Boston, Massachusetts, Springfield, Massachusetts and Hartford, Conneticut participated in the study. The participating banks were

(1) Conneticut Bank & Trust Company

(2) Hartford National Bank

(3) Society for Savings

(4) Third National Bank of Hampden County

(5) Valley Bank

(6) First National Bank of Boston

(7) New England Merchants National Bank

(8) Shawmut County Bank

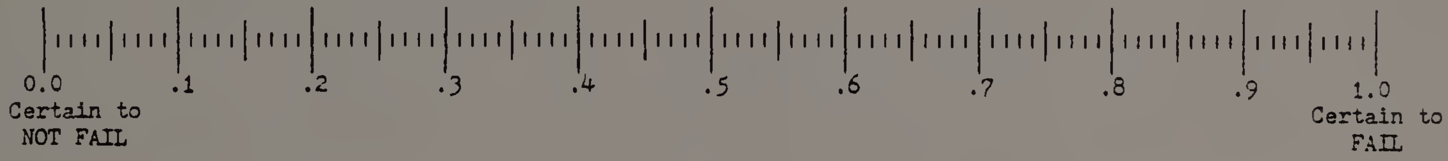
(9) Commonwealth Bank and Trust Company

The volunteers were arranged by a senior bank officer to whom a telephone request for participants was made. After contacting the banks by telephone, questionnaires were mailed out with accompanying instructions. The bankers were requested to complete and return the questionnaires within a two week time period. The time involved in filling out the questionnaire was approximately one hour. Initially, thirty-eight participants were volunteered by the senior bank officers. Of the original thirty-eight, twenty-four actually completed and returned the questionnaire, giving a usable response rate of 63 percent.

Procedures During the Experiment

The participants were given a questionnaire and an accompanying set of instructions as to the procedures to be followed and the tasks to be performed. They were informed that the responses they were giving were subjective in nature and that there was no correct or incorrect answer to the problem. The participants were also informed that the sample of firms consisted of six firms, three of which eventually went bankrupt and three of which were still going concerns. In addition to this information, they were also told that the current-cost financial ratios were computed from financial statements that were prepared on a replacement cost basis following the guidelines set forth by the SEC in ASR/190.

A uniform scale from 0.0 to 1.0 was used to collect the participants probability judgments. A response of 1.0 indicates that a firm will fail with certainty, and a 0.0 indicates that a firm has zero probability of failing over the appropriate time span. A response of 0.5 indicates that failure and nonfailure are equally probable. The scale used in the study is depicted below.



Since the classification of failure is dichotomous in nature, i.e., either fail or not fail, a judgment of the probability of failure also implies a judgment of the probability of nonfailure. Probability of nonfailure equals one minus the probability of failure. The participants were instructed to bear this relationship in mind when making their probability judgments.

At the beginning of each set of information for a particular information class and time period, the participants were informed of the information class and time period and asked to make their probability judgments within the appropriate framework.

The participants were given the financial information on separate slips of paper for each of the five items of information for each firm. This was accomplished by slicing the questionnaire shown in the appendix so that one firm could be turned at a time. The first slip was to determine the prior probabilities of the subjects about failure. Prior probabilities concerning failure may be based upon several factors, such as the unconditional probability of failure for all firms, the industry in which the firm operates, asset size, or the quality of management.[15] To establish prior probabilities, the first slip of information for each firm contained the total asset size of the firm. The next four slips contained the ratio information. On each slip containing ratio data, the following was presented: the definition of the ratio, the numerical value of the ratio, and the one-hundred point scale for their response. After observing each slip of information, the participants were asked to place a mark on the probability scale that represented their judgment of the chance of the firm failing in the appropriate time span.

The probability judgments made by the participants were then used to compute the inferred likelihood odds ratios which were used as the dependent variable in the data analysis. A computer program was used to perform the computations necessary to make the conversion to the likelihood odds ratios.[16] The inferred likelihood odds ratios were then tested for differences between the information classes. Chapter five describes the tests and their results.

FOOTNOTES

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[3]Ibid.

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[11]Dale Buckmaster and Leroy Brooks, "The Effects of Price-Level Changes on Operating Income," CPA Journal, (May 1974), pp. 49-53.

[12]W. Edwards; L.D. Phillips; W.L. Hays; and B.C. Goodman,"Probabilistic Information Processing Systems: Design and Evaluation," IEEE Transactions on Systems Science and Cybernetics, SSC-4, (1968), pp. 248-265.

[13]D.A. Schum, "Inferences on the Basis of Conditionally Nonindependent Data," AMRL Technical Report, pp. 65-161.

[14]James O. Horrigan, "Some Empirical Bases of Financial Ratio Analysis," The Accounting Review, 40, (July 1965), pp. 558-568.

[15]Beaver, loc. cit.

[16]The computer program was developed and written by Stu Westin.

CHAPTER V

ANALYSIS OF THE DATA

Introduction

For the analysis of the differences between the classes of information, the dependent variable was the inferred likelihood odds ratio. The analysis could be carried out in terms of the posterior odds ratio, however, the posterior odds would be largely affected by the probability of failure for this particular sample which is different from the probability of failure for all firms in the economy. The likelihood odds ratio will be unaffected by the probability of failure in the sample and, therefore, carry with them a degree of generality. If the ratio distribution of the sample is the same as the ratio distribution of the population, the numerical value of the likelihood ratios from the sample will be the same ones that apply to the population even though the frequency of failure in the sample is vastly different from that of the entire population.

Odds in favor of failure were computed from the judgments of the probability of failure made by the participants. The odds were then used to calculate the inferred likelihood odds ratio for each probability revision.

The analysis of the data is broken down into two sections. The first section deals with descriptions of the mean likelihood odds ratios for the three measurement classes. The second section deals with hypothesis testing for differences between the likelihood odds ratios for the three measurement classes.

Descriptive Results

The data was first dichotomized into two parts, one part containing the responses for information that was presented for three years prior to failure and for one year prior to failure. The responses were then separated by their respective information class and the financial ratio from which they were derived. Table 4 shows the mean value of the likelihood odds ratio (impact) for each of the four financial ratios for each of the three information classes for both time periods one and three years before failure. The higher the numerical value of the likelihood odds ratio, the more information that the financial ratio conveyed to the userin predicting failure. If the likelihood odds ratio is greater than one, the user of the ratio after having looked at the firm's financial ratio will have revised his probability of failure or nonfailure in the proper direction.[1] The higher the value of the likelihood odds ratio, the greater the revision. If the likelihood odds ratio is less than one, the feelings of the user would be moved in the improper direction. If the likelihood odds ratio equals one, the prior feelings of the user are unchanged after viewing the financial ratio. The diagnosticity of information content of the financial ratios and the classes of information can be evaluated in terms of the degree to which they change the prior feelings about failure or nonfailure. The higher the value of the likelihood odds ratio, the more information or diagnosticity of the measurement base.

Table 4

Mean Inferred Likelihood Ratio for the Four Financial Ratios and the Three Information Classes

Information Class	One Year Prior			Three Years Prior		
Financial Ratio	Historical Cost	Current Cost	Both	Historical Cost	Current Cost	Both
Owner's Equity/Total Debt Impact	4.68	11.73	6.10	4.20	2.85	1.78
Net Income/Total Assets Impact	2.09	3.60	2.44	3.96	4.77	7.20
Current Assets/Total Assets Impact	1.04	1.24	1.23	1.34	1.77	1.14
Current Assets/Current Liabilities Impact	2.78	2.20	3.15	4.53	1.93	2.22

Figure 5 presents Table 4 graphically. It can be seen from Table 4 and Figure 5 that the effects of the three measurement bases on the subjects' likelihood odds ratios varies between the different financial ratios and the two different time periods. For one year prior to bankruptcy the financial ratios owner's equity/total debt, net income/total assets and current assets/total assets measured on a current-cost basis appear to have the greatest impact on the user's probability revisions. The financial ratio current assets/current liabilities has the greatest impact when presented on both historical cost and current-cost bases. For the time period three years prior to bankruptcy the financial ratios owner's equity/total debt and current assets/current liabilities appear to have the greatest impact when measured on a historical cost basis. The financial ratio net income/total assets has the greatest impact when presented on both a historical cost and a current-cost basis and the financial ratio current assets/total assets has the greatest impact when presented on a current-cost basis.

Different firms possess different numerical values for the financial ratios and the effect of converting from historical cost to current-cost differs from firm to firm. Mean values of the likelihood odds ratios were computed for each financial ratio for each firm for each measurement base. The results are summarized in Table 5, and Figures 6 through 9 presents these results graphically. Inspection of Table 5 and Figures 6 through 9 reveal that the effect of the information classes upon the subjects' likelihood odds ratios varies from firm to firm for a given financial ratio.

Figure 5

Mean Inferred Likelihood Ratios for the Four Financial Ratios and the Three Information Classes

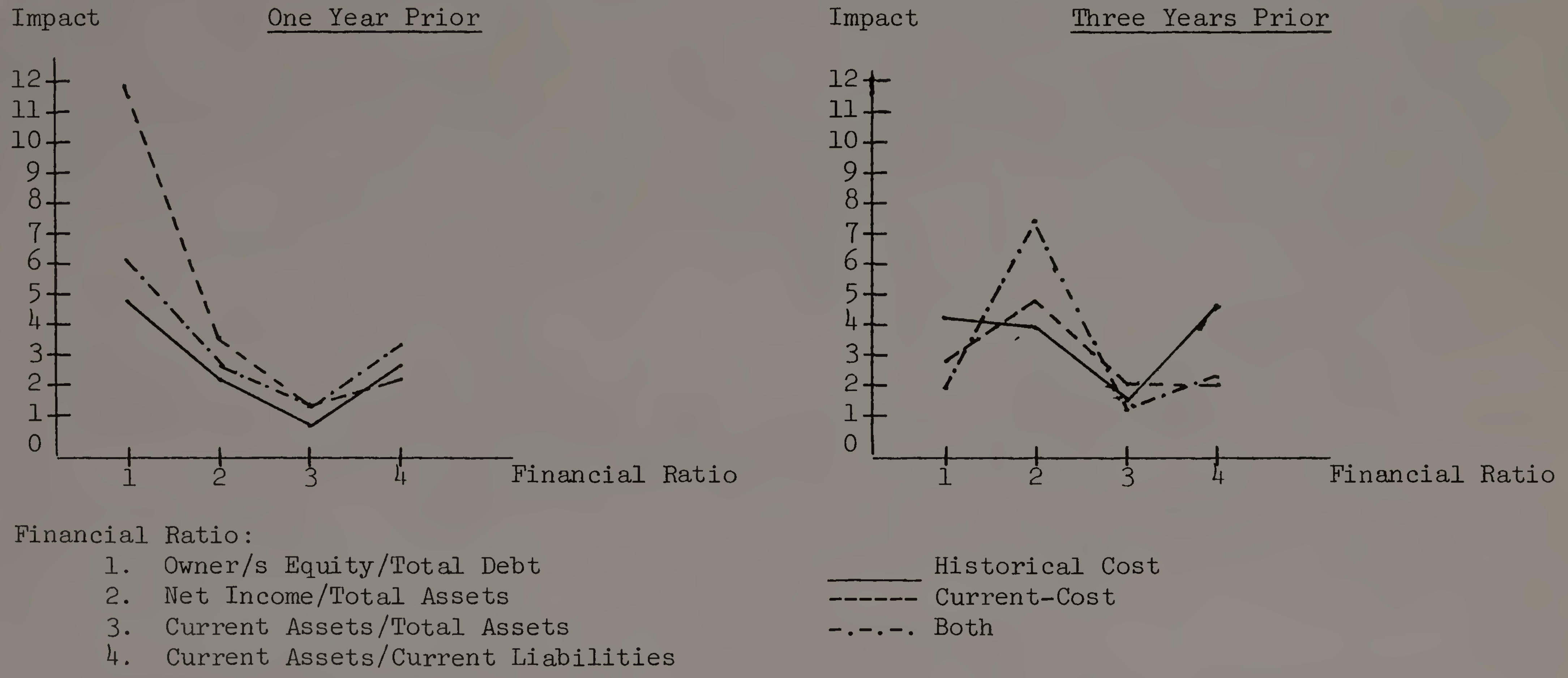


Table 5

Mean Inferred Likelihood Ratio For Each Firm and the Three Information Classes

	One Year Prior						Three Years Prior					
Firm Number*	1	2	3	4	5	6	1	2	3	4	5	6
Owners Equity/Total Debt												
Impact - H.C.**	4.31	2.61	1.02	11.48	5.23	3.41	0.82	3.27	2.18	16.37	0.68	1.86
Impact - C.C.	15.93	1.02	4.16	13.76	34.59	0.92	1.33	1.14	2.17	8.88	2.07	1.48
Impact - Both	5.37	1.31	10.34	7.88	9.07	2.61	1.15	1.34	2.90	2.73	1.54	1.02
Net Income/Total Assets												
Impact - H.C.	2.90	0.62	1.50	1.18	4.37	1.96	3.15	1.88	11.05	0.74	2.84	4.10
Impact - C.C.	13.48	0.78	1.77	0.89	2.94	1.71	2.88	3.08	12.62	0.81	6.88	2.34
Impact - Both	3.87	0.50	4.98	0.90	2.54	1.86	2.77	2.20	29.45	1.34	4.53	2.90
Current Assets/ Total Assets												
Impact - H.C.	0.78	1.16	1.21	1.62	0.84	0.61	2.54	1.09	0.41	1.68	1.33	1.01
Impact - C.C.	1.29	1.72	0.97	1.42	0.53	1.48	5.06	2.02	0.85	0.67	0.95	1.06
Impact - Both	1.76	2.07	0.96	1.12	0.73	0.76	1.46	1.53	0.60	1.25	0.84	1.16
Current Assets/ Current Liabilities												
Impact - H.C.	0.73	1.21	0.90	10.20	1.28	2.34	5.43	1.16	1.67	15.25	1.85	1.79
Impact - C.C.	0.48	1.50	0.83	6.13	1.10	3.18	2.76	1.16	1.33	3.68	1.05	1.58
Impact - Both	0.73	2.74	0.79	10.22	1.12	3.31	1.63	0.87	2.03	6.53	1.02	1.22

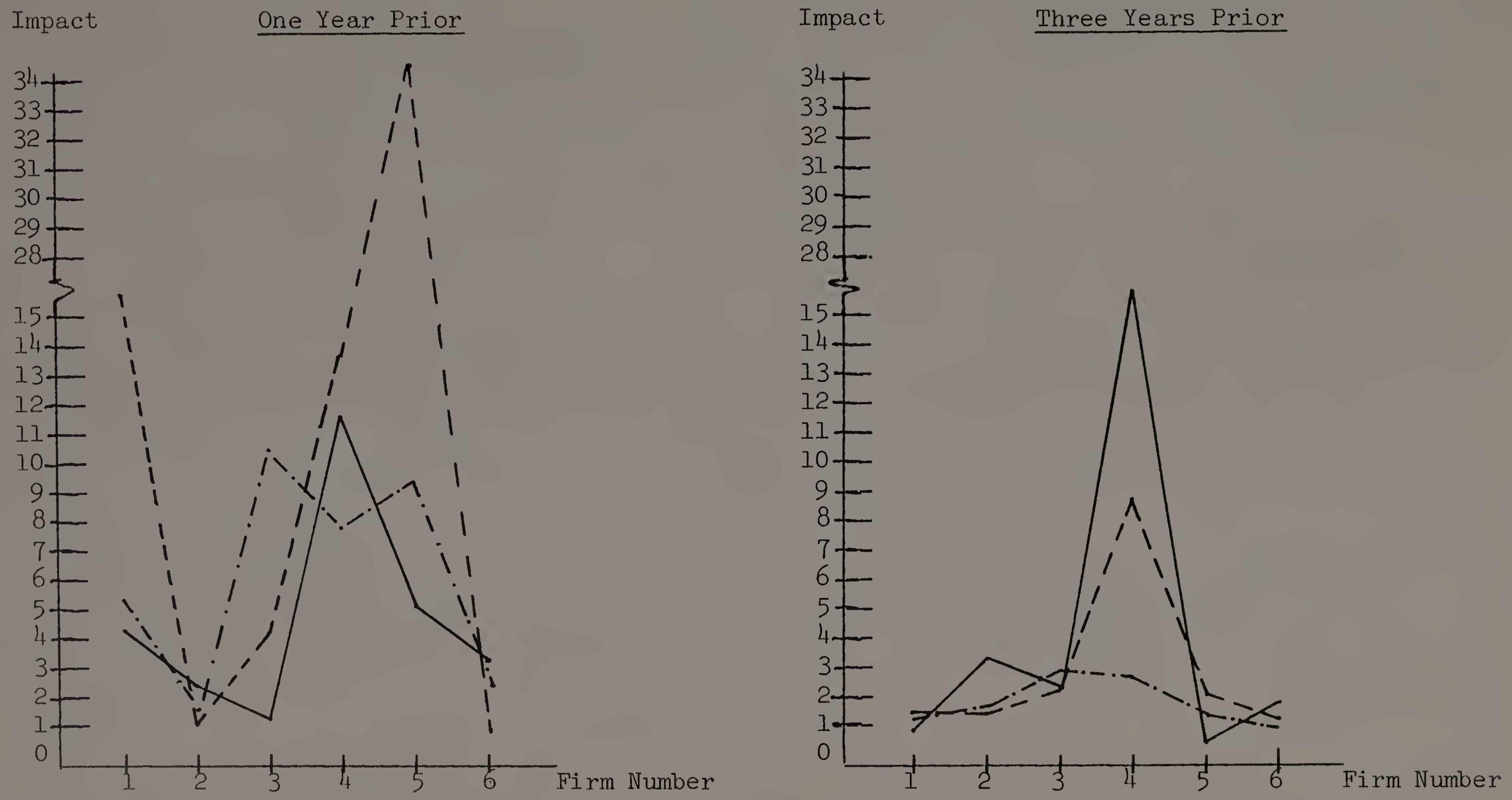
* Odd numbered firms are bankrupt and even numbered firms are nonbankrupt.

** H.C. - Historical Cost, C.C. - Current-Cost, Both - Both Historical Cost and Current-Cost.

Figure 6

Mean Inferred Likelihood Ratio For Each Firm
and the Three Information Classes

Financial Ratio: Owners Equity/Total Debt



______ Historical Cost ------ Current-Cost -.-.-. Both

Figure 7

Mean Inferred Likelihood Ratio For Each Firm
and the Three Information Classes

Financial Ratio: Net Income/Total Assets

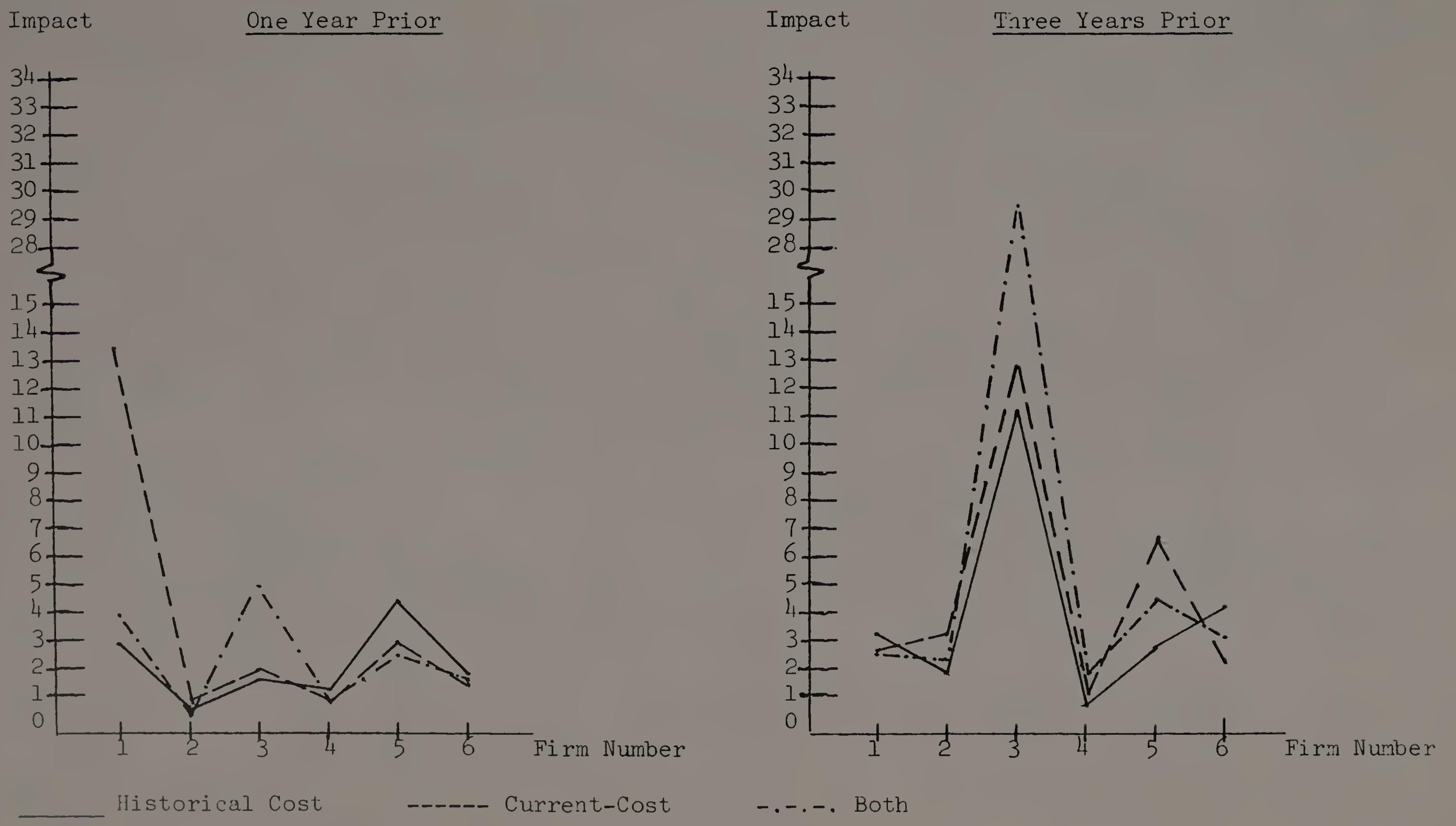


Figure 8

Mean Inferred Likelihood Ratio For Each Firm and the Three Information Classes

Financial Ratio: Current Assets/Total Assets

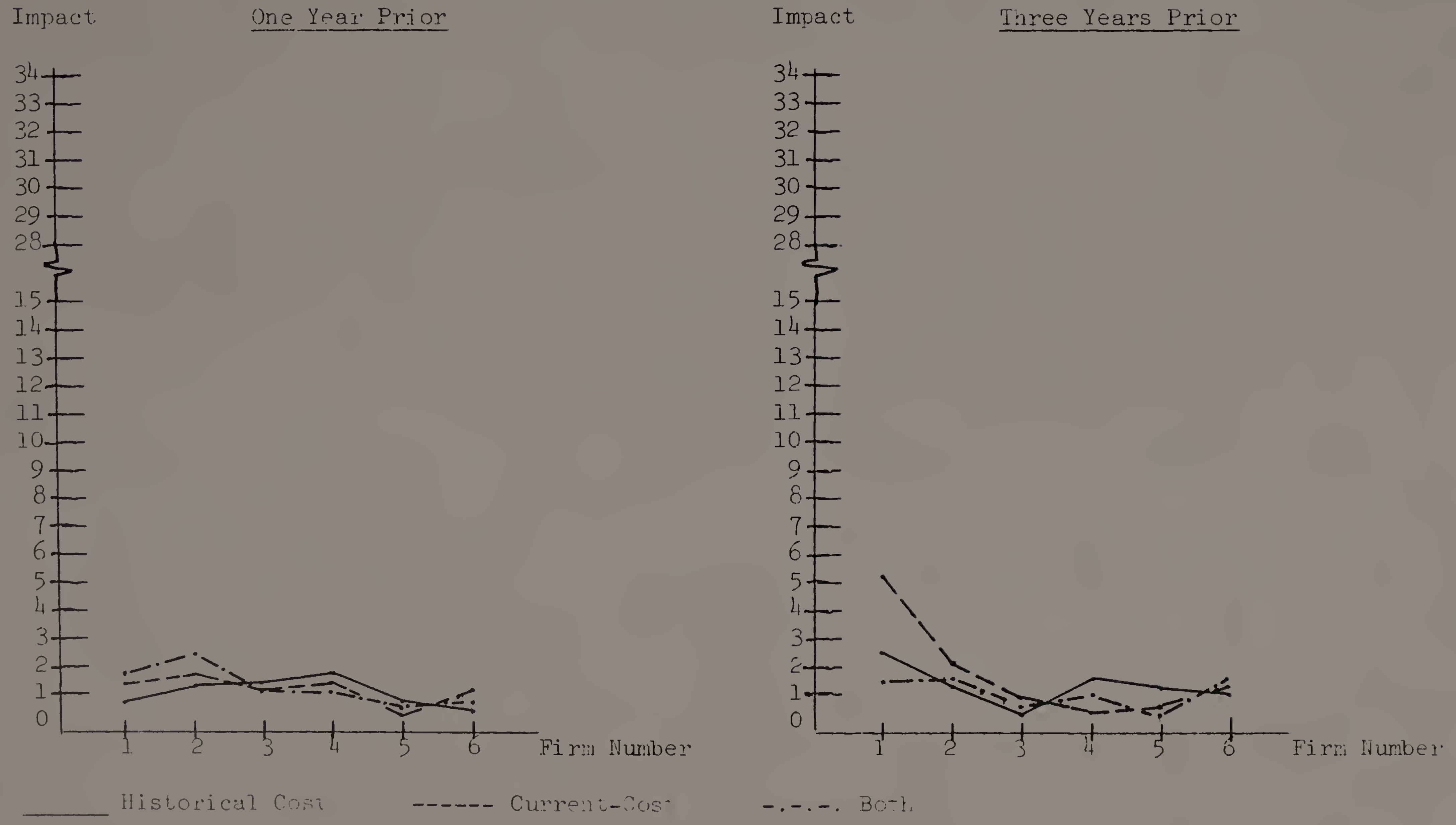
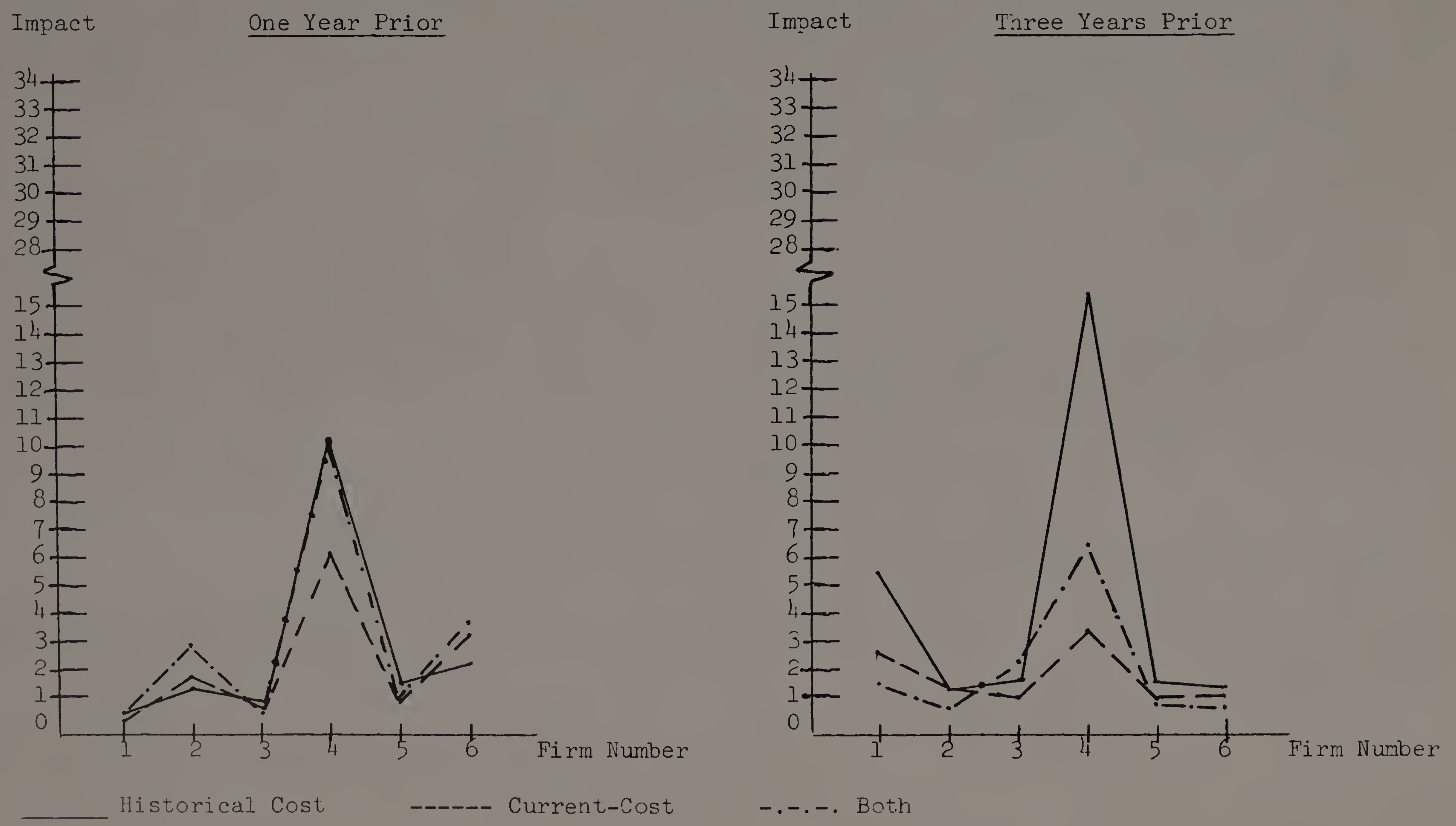


Figure 9

Mean Inferred Likelihood Ratio For Each Firm
and the Three Information Classes

Financial Ratio: Current Assets/Current Liabilities



A breakdown was also made between bankrupt and non bankrupt firms. The mean likelihood odds ratio for bankrupt firms and non bankrupt firms was computed for each of the three information classes for all four financial ratios. Table 5.3 summarizes these results. Figures 10 through 13 present these results graphically. Inspection of Table 6 and Figures 10 through 13 reveal that the effect of the alternative measurement bases on the inferred likelihood ratios can vary considerably for bankrupt versus non bankrupt firms.

It is easy to see by examining the Tables and graphs in this first section that there are differences in the inferred likelihood ratios that were derived from the three information classes. The second section of the analysis chapter tests whether these differences are statistically significant.

Hypothesis Testing

The hypothesis testing section is comprised of three main parts, one for each of the statistical techniques employed in the study. Part one presents the results of a parametric technique, analysis of variance. Parts two and three present the results of two nonparametric tests, Friedman's Analysis of Variance and Cochran's Q. Each test was performed three times for each of the four financial ratios, once for the information that was from the time period one year prior to failure, once for the information that was from the time period three years prior to failure, and finally for both years of data combined.

Table 6

Mean Inferred Likelihood Ratio For Bankrupt and Nonbankrupt Firms and Three Information Classes

	One Year Prior		Three Years Prior	
	Bankrupt	Nonbankrupt	Bankrupt	Nonbankrupt
Owner's Equity/Total Debt				
Impact - H.C.*	3.52	5.83	1.23	7.17
Impact - C.C.	18.23	5.23	1.86	3.83
Impact - Both	8.26	3.93	1.86	1.70
Net Income/Total Assets				
Impact - H.C.	2.92	1.25	5.68	2.24
Impact - C.C.	6.06	1.17	7.46	2.08
Impact - Both	3.80	1.08	12.25	2.14
Current Assets/Total Assets				
Impact - H.C.	0.94	1.13	1.43	1.26
Impact - C.C.	0.93	1.54	2.29	1.25
Impact - Both	1.15	1.32	0.97	1.31
Current Assets/Current Liabilities				
Impact - H.C.	0.97	4.56	2.98	6.07
Impact - C.C.	0.80	3.60	1.71	2.14
Impact - Both	0.88	5.43	1.56	2.87

*H.C. - Historical Cost, C.C. - Current-Cost, Both - Both Historical Cost and Current-Cost.

Figure 10

Mean Inferred Likelihood Ratio For Bankrupt and Nonbankrupt Firms and Three Information Classes

Financial Ratio: Owner's Equity/Total Debt

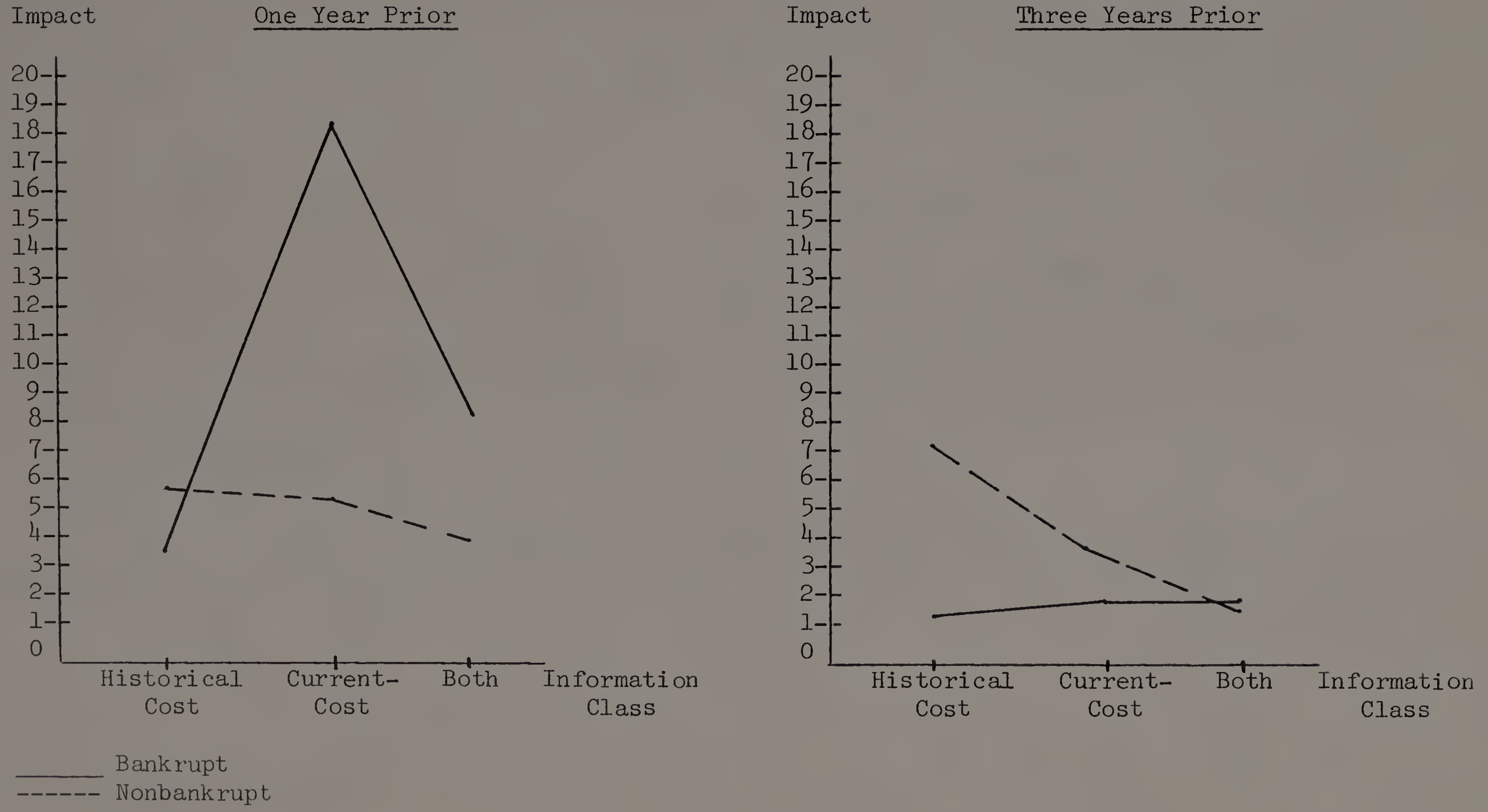


Figure 11

Mean Inferred Likelihood Ratio For Bankrupt and Nonbankrupt Firms and Three Information Classes

Financial Ratio: Net Income/Total Assets

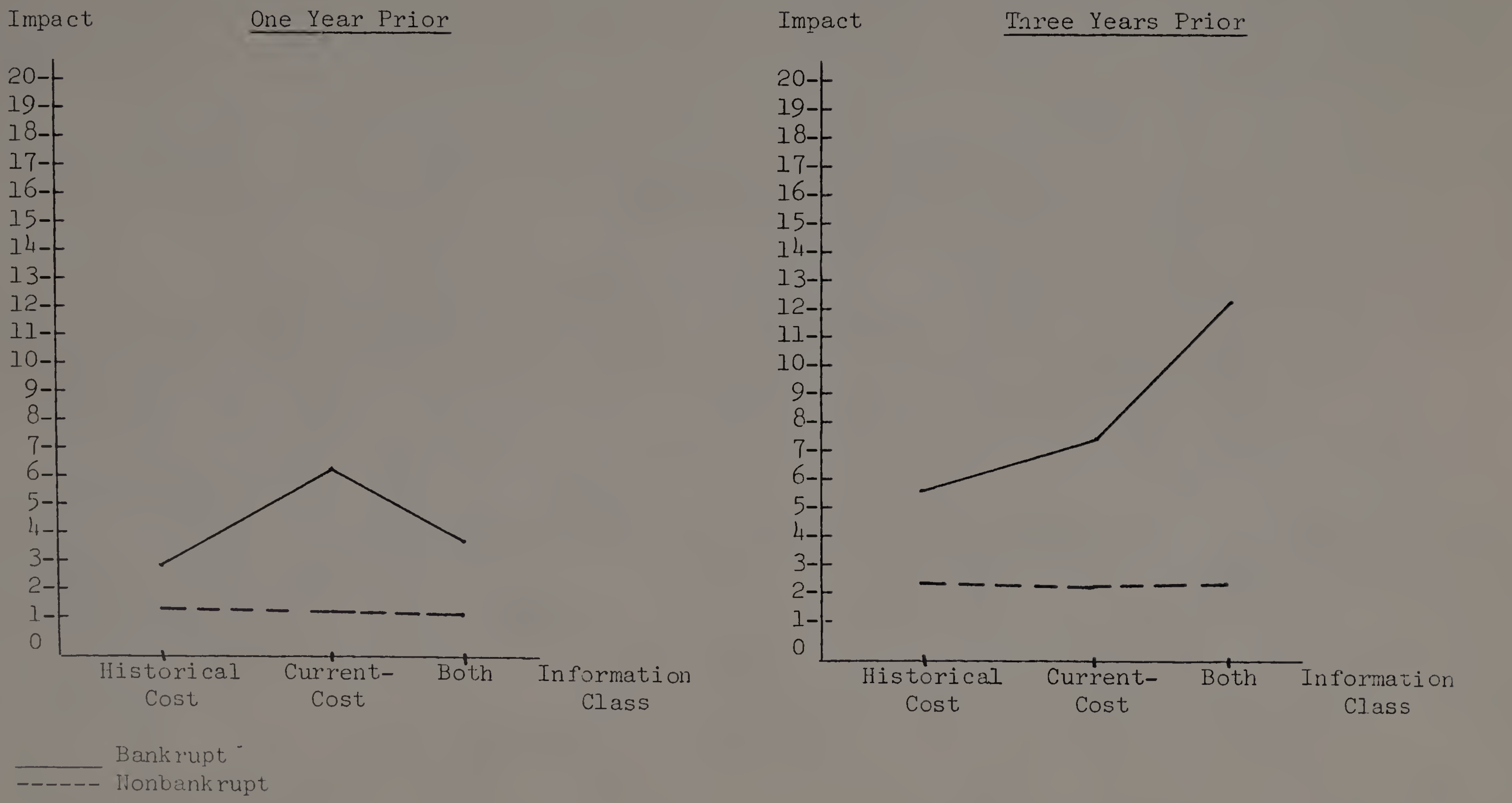


Figure 12

Mean Inferred Likelihood Ratio For Bankrupt and Nonbankrupt Firms and Three Information Classes

Financial Ratio: Current Assets/Total Assets

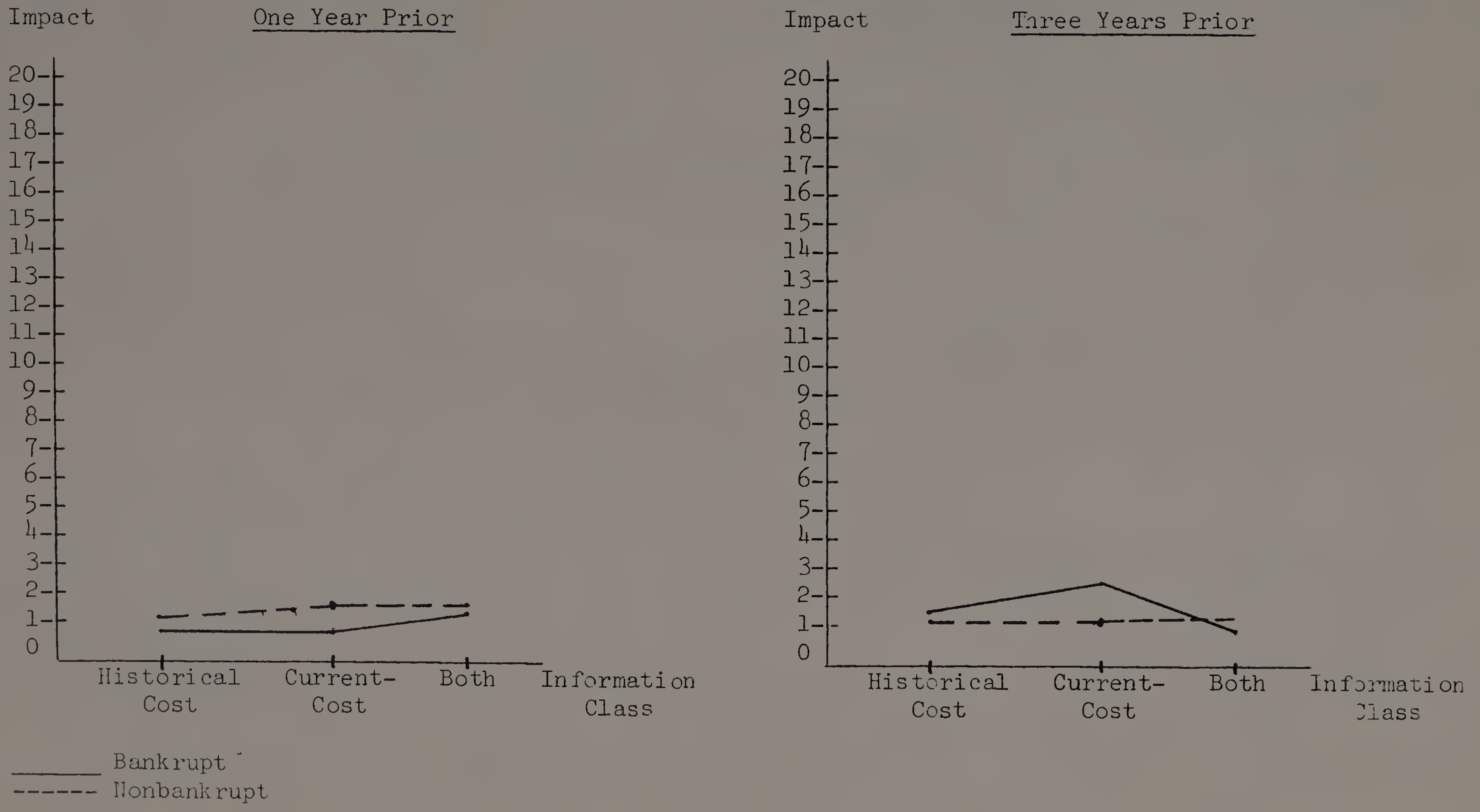
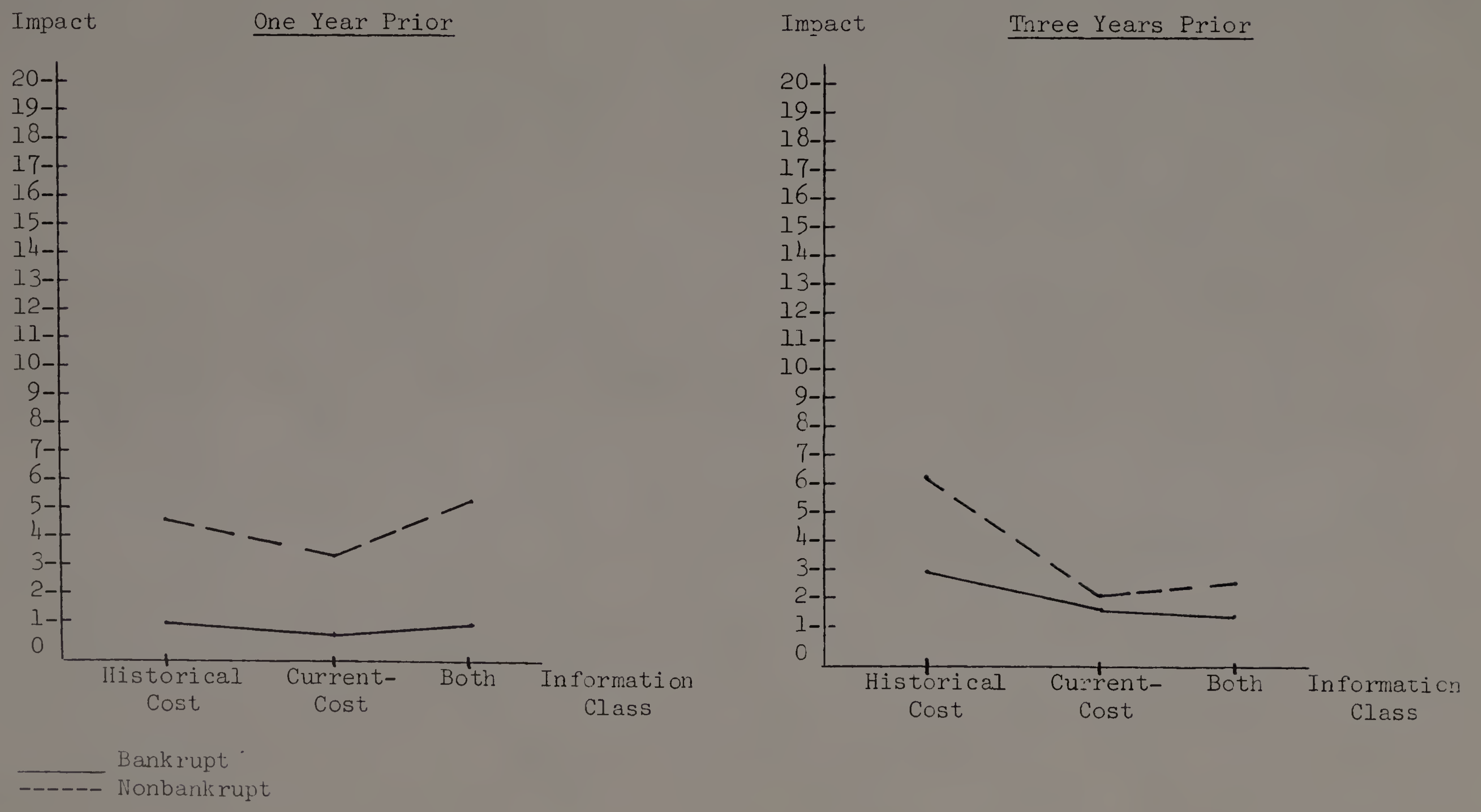


Figure 13

Mean Inferred Likelihood Ratio For Bankrupt and Nonbankrupt Firms and Three Information Classes

Financial Ratio: Current Assets/Current Liabilities



Analysis of variance. The model of measurement in the parametric case can be represented as:

$$T_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + \alpha\beta_{ij} + \alpha\gamma_{ik} + \beta\gamma_{jk} + \alpha\beta\gamma_{ijk} + \varepsilon_{ijk}$$

This notation suggests that the potential experimental measurement, T_{ijk}, can be represented by the overall mean of the subject population, μ, plus the effect due to the fact that the subject received financial ratio information from the ith information class, α_i, received the jth information class sequence, β_j, plus the fact that the information was from the kth firm, γ_k, plus the interaction effects of these variables, $\alpha\beta_{ij}$, $\alpha\gamma_{ik}$, $\beta\gamma_{jk}$, $\alpha\beta\gamma_{ijk}$, plus any error involved in observing the subject in this situation, ε_{ijk}.

The analysis of variance tests whether population means are equal by making a comparison of separate estimates of the population variance. The null hypothesis is that population means are equal. The null hypothesis being tested is:

Ho: There is no significant difference between the mean inferred likelihood ratios for a given financial ratio between the three classes of information.

The data was run on SPSS-Anova to arrive at the F-values used in the analysis.

Both years. The results for the data set wherein both years are combined together to test for significant differences is presented in Table 7. It can be seen by examination of Table 7 that the null hypothesis can be rejected for two of the financial ratios, owner's equity/total debt and net income/total assets. The financial ratio

Table 7

Mean Inferred Likelihood Ratios and Degree of Significance of F for the Three Information Classes for Both Years Together

	Historical Cost	Current Cost	Both H.C. & C.C.	Significance of F
Owner's Equity/Total Debt				
Mean LR	4.44	7.29	3.94	.001
Net Income/Total Assets				
Mean LR	3.03	4.19	4.82	.038
Current Assets/Total Assets				
Mean LR	1.19	1.51	1.19	.379
Current Assets/Current Liabilities				
Mean LR	3.66	2.07	2.68	.247

owner's equity/total debt appears to have the greatest impact on a user's probability revision when the financial ratio is computed using current-cost financial information. The financial ratio net income/ total assets appears to have the greatest impact on a user's probability revision when the financial ratio is presented to the user on both historical cost and current-cost bases. The null hypothesis that the mean likelihood ratios are equal for the three information classes for the financial ratios current assets/total assets and current assets/ total liabilities cannot easily be rejected.

Three years. Analysis of variance was performed separately for each time period, one and three years prior to failure. The null hypothesis remains the same that there is no significant differences in the mean inferred likelihood rations for three information classes for a given financial ratio. Table 8 presents the results of the SPSS-Anova program for the data set three years prior to bankruptcy. Examination of Table 8 reveals that the null hypothesis could be rejected for two of the financial ratios, current assets/current liabilities and owner's equity/ total debt. The ratio current assets/current liabilities appears to have the greatest impact when the financial ratio is computed from historical cost financial statements. For three years prior to bankruptcy the financial ratio owner's equity/total debt has the greatest impact upon a user's probability revision when also computed from historical cost financial statements. It is difficult to reject the null hypothesis for the financial ratios net income/total assets and current assets/total assets at these significance levels, there is,

Table 8

Mean Inferred Likelihood Ratios and Degree of Significance of F for the Three Information Classes for Three Years Prior to Bankruptcy

	Historical Cost	Current Cost	Both H.C. & C.C.	Significance of F
Owner's Equity/Total Debt				
Mean LR	4.20	3.85	1.78	.133
Net Income/Total Assets				
Mean LR	3.96	4.77	7.20	.278
Current Assets/Total Assets				
Mean LR	1.34	1.77	1.14	.402
Current Assets/Current Liabilities				
Mean LR	4.53	1.93	2.22	.063

however, a slightly greater impact when these ratios are presented on both bases simultaneously and current-cost respectively.

One year. The mean inferred likelihood ratios and the significance level of F from SPSS for the time period one year prior to bankruptcy is presented in Table 9. Examination of Table 9 indicates that the null hypothesis can be rejected for the financial ratio owner's equity/total debt. The financial ratio conveys the most information to the user when the ratio has been computed from current-cost financial statements. It is difficult to reject the null hypotheses for the other three financial ratios.

Discussion. It is difficult to draw hard and fast conclusions that one information class clearly provides information that has a different impact upon the users of that information system. The relative impact of the different information classes appears to be conditional upon which financial ratio is being realized, and the time period from which the financial ratio was computed. The results are further complicated by firm effects and firm and measurement base interactions. Conversion to current-cost has differing effects upon the numerical value of a financial ratio due to the age and composition of the assets of a particular firm. The firm effects were significant at the .001 level for all four financial ratios for both years combined and the information class and firm interaction was significant for all the financial ratios at the $p < .10$ level except for the ratio current assets/current liabilities which did not have a significant interaction effect ($p < .739$). Only one of the financial ratios contained a

Table 9

Mean Inferred Likelihood Ratio and Degree of Significance of F for the Three Information Classes for One Year Prior to Bankruptcy

	Historical Cost	Current Cost	Both H.C. & C.C.	Significance of F
Owner's Equity/Total Debt				
Mean LR	4.68	11.73	6.10	.041
Net Income/Total Assets				
Mean LR	2.09	3.60	2.44	.399
Current Assets/Total Assets				
Mean LR	1.04	1.24	1.23	.262
Current Assets/Current Liabilities				
Mean LR	2.78	2.20	3.15	.699

significant information class sequence effect. The sequence effect for the financial ratio owner's equity/total debt was significant at the .001 level. The greatest difference came about when the current-cost information was presented first to the subjects and the first time period present was the time period three years prior to bankruptcy. The other interaction effects were not significant at the .01 level.

The analysis of variance gives information as to the differences in impact of the three information classes, but the test ignores the accuracy of the direction of the probability revision. The second test performed on the data, Friedman's analysis of variance examines this aspect of the probability revisions.

Friedman's two-way analysis of variance. The second part of the data analysis is concerned with whether one of the information classes provided "better" information to the user. This was examined by looking at degrees of accuracy of the direction of the impact on the prior odds in favor of failure. With odds stated in favor of bankruptcy, a financial ratio for a bankrupt firm will have an accurate direction of impact if it increases the odds in favor of bankruptcy. In this case, the likelihood ratio will be greater than one. A financial ratio for a nonbankrupt firm will have an accurate impact if it decreases the odds in favor of bankruptcy. The likelihood ratio will now be less than one. Table 10 shows the relationship between accuracy and the direction of impact.

Table 10

Usefulness of Financial Ratios
Measured in Terms of the Accuracy of
the Direction of Their Impact on the
Prior Odds in Favor of Bankruptcy

		Financial ratio taken from a firm classified as:	
		Bankrupt	Nonbankrupt
Likelihood ratio for the financial ratio	>1 (favors bankruptcy)	Accurate	Inaccurate
	<1 (favors nonbankruptcy)	Inaccurate	Accurate

"Better"information was examined within this framework on a relative basis, i.e. in terms of the relative impact and accuracy of direction that the financial ratios from the different information classes have on the prior odds.

The greater the difference between the likelihood odds ratio and one, the greater the impact the piece of data has on the revision of the probabilities. The stronger the impact, the stronger the statement that will be made concerning the probability of failure or nonfailure. The "best" class of information would be that class which causes the greatest revision in the proper direction, or if all of the information classes cause revision in the wrong direction, the one that caused the least revision in the wrong direction. This quality evaluation can be accomplished by a simple ranking of the likelihood odds ratios for the three information classes for a given participant and financial ratio. If the true state of nature is failure, rank the likelihood odds ratios from highest to lowest. In this case, the highest likelihood odds ratio indicates the best class of information. If the true state of nature is nonfailure, rank the likelihood odds ratio from the lowest to the highest. When nonfailure is the true state of nature, the information class that yields the lowest likelihood odds ratio will be the best class of information. Table 11 presents the ranking rules.

Table 11

Ranking Rules for the Usefulness of Financial Ratios Measured in Terms of the Accuracy of the Direction and Magnitude of Their Impact on the Prior Odds in Favor of Bankruptcy

Financial ratio taken from a firm classified as:	Best Class of Information:	Order of Ranking
Bankrupt	Highest likelihood ratio	Highest likelihood ratio to lowest likelihood ratio
Nonbankrupt	Lowest likelihood ratio	Lowest likelihood ratio to highest likelihood ratio

The null hypothesis concerning the quality of information contained in the different information classes is:

Ho: There is no significant difference in the rankings of the likelihood odds ratios between the different information classes for a given financial ratio.

The alternative hypothesis is that one of the alternative information classes provides better information to the user. The "best" information class for a particular financial ratio will be the class which was consistently ranked one with the above ranking scheme.

The Friedman two-way analysis of variance by ranks is the appropriate statistic to test whether the k related samples could probably have come from the same population with respect to mean ranks.

For the Friedman test, the data are cast in a two-way table having N rows and h columns. The rows represent the subjects and the columns represent the various conditions (information classes). The Friedman test determines whether the rank totals differ significantly. Friedman denotes the statistic as X_r^2 and has demonstrated that X_r^2 is distributed approximately as chi square with df = h - 1, when[2]

$$X_r^2 = \frac{12}{Nh\ (h + 1)} \sum_{j=1}^{h} (R_j)^2 - 3N\ (k + 1)$$

where N = number of rows

h = number of columns

R_j = sum of ranks in jth column

$\sum_{j=1}^{h}$ directs one to sum the squares of the sums of ranks over all h conditions.

Friedman's analysis of variance was performed on the rankings of the likelihood odds ratios using SPSS for both years data combined together and one and three years prior to bankruptcy.

Both years. The mean ranks, chi square, and the level of significance from the Friedman test for both years taken together is presented in Table 12. Examination of Table 12 reveals that the null hypothesis of no significant difference in the rankings for the three information classes can be rejected for three of the financial ratios. The lower the mean ranking for an information class, the more frequently that information was ranked as the "best" information class. Thus the two financial ratios owner's equity/total debt and net income/total assets

Table 12

Mean Ranks, Chi Square and Level of Significance for the Freidman Test for Both Time Periods Combined

	Mean Ranks				
Financial Ratio/Information Class	Historical Cost	Current-Cost	Both H.C. & C.C.	Chi Square	Level of Significance
Owner's Equity/Total Debt	2.047	1.873	2.080	7.0955	.0288
Net Income/Total Assets	2.113	1.891	1.997	7.1163	.0285
Current Assets/Total Assets	2.033	2.0122	1.955	.9427	.6242
Current Assets/Current Liabilities	1.885	2.083	2.031	6.0625	.0483

appear to provide the best information when presented on a current-cost basis. The financial ratio current assets/current liabilities appears to provide the best information when presented on a historical cost basis. There seems to be no significant difference between the information classes for the financial ratio current assets/total assets.

Three years. The mean ranks, chi square and the level of significance for the Friedman test for the time periods three years and one year prior to bankruptcy are presented in Table 13. Examination of Table 13 under three years prior indicates that the null hypothesis can be rejected for two of the financial ratios, net income/total assets and current assets/current liabilities. For the time period three years prior to bankruptcy the financial ratio net income/total assets appears to provide the best information when presented on both a historical cost basis and a current cost basis. The financial ratio current assets/current liabilities provides the best information three years prior to bankruptcy when presented on a historical cost basis. The null hypothesis for the financial ratio owner's equity/total debt could possibly be rejected if one wishes to accept the significance level of .1461. This financial ratio when presented on a current cost basis appears to provide the best information.

One year. Inspection of Table 13 under one year prior indicates that the null hypothesis can be rejected for the financial ratio net income/total assets. The best information class for this financial ratio one year prior to bankruptcy is current cost financial information. Again, the null hypothesis for the financial ratio owner's equity/total debt

Table 13

Mean Ranks, Chi Square and Level of Significance for the Friedman Test for Three Years Prior to Bankruptcy and One Year Prior to Bankruptcy

Financial Ratio/Information Class	Mean Ranks: Historical Cost	Mean Ranks: Current-Cost	Mean Ranks: Both H.C. & C.C.	Chi Square	Level of Significance
Three Years Prior					
Owner's Equity/Total Debt	2.083	1.868	2.049	3.8472	.1461
Net Income/Total Assets	2.184	1.927	1.889	7.4201	.0245
Current Assets/Total Assets	1.986	2.024	1.990	.1285	.9378
Current Assets/Current Liabilities	1.788	2.052	2.160	10.5243	.0052
One Year Prior					
Owner's Equity/Total Debt	2.010	1.878	2.111	3.9201	.1408
Net Income/Total Assets	2.042	1.854	2.104	4.8750	.0874
Current Assets/Total Assets	2.080	2.00	1.920	1.8368	.3992
Current Assets/Current Liabilities	1.983	2.115	1.903	3.2951	.1925

could be rejected at the .1408 level. The current-cost information class appears to provide the best information.

Discussion. Overall, the financial ratios owner's equity/total debt and net income/total assets provided the "best" information when presented on a current cost basis. The financial ratio current assets/current liabilities provided the "best" information when presented on a historical cost basis. There was no significant difference between the information classes for the financial ratio current assets/total assets. These results indicate again that the impact of the different information classes on the inferred likelihood odds ratios differs for the four financial ratios. With these mixed results it is difficult to say that overall one information class provides the best information for predicting business failures, however, the different information classes do have significantly different effects upon the impact that the financial ratios have upon the user.

Cochran's Q test. Under the Friedman test described above, it would be possible for an information class for a particular financial ratio to push subjects' probabilities toward the false state of nature and still be classified as the "best" information class. This could happen when all three information classes cause revision in the improper direction and the "best" would be the information class that had the least revision in the wrong direction. "Best" could also be interpreted as the measurement base which most consistently caused probability revisions in the proper direction for a given financial ratio. For a bankrupt firm, a likelihood ratio greater than one would cause revision in the proper direction and for a nonbankrupt firm, a likelihood ratio less than one would cause a revision in the proper direction. A revision in the proper direction would be considered a correct response and a revision in the wrong direction or no revision would be considered an uncorrect response. The "best" information class for a particular financial ratio could be considered as the class having the highest proportion of correct responses. The Cochran Q test for h related samples provides a method for testing whether three or more matched sets of frequencies or proportions differ significantly among themselves. Cochran has shown that if the null hypothesis of no significantly different proportions is true, then the Q statistic,

$$Q = \frac{h(h-1) \sum_{j=1}^{h} (G_j - \bar{G})^2}{h \sum_{i=1}^{w} L_i - \sum_{i=1}^{n} L_i^2}$$

is distributed approximately as chi square with df = h-1,

where G_j = total number of correct responses in jth column,

$\bar{G}$ = mean of the G_j

L_i = total number of correct responses in the ith row

The likelihood ratios were classified as being correct or incorrect as described above, and the following null hypothesis was examined using the Cochran Q test.

Ho: There is no significant difference in the proportion of correct responses between the three information classes for a given financial ratio.

Both years. Table 14 presents the percentage of correct and incorrect classifications, Cochran's Q and the level of significance for both time periods together. Examination of Table 14 reveals that the null hypothesis can be rejected for the financial ratio owner's equity/total debt. A significantly higher proportion of the likelihood ratios which were generated by the current-cost information class were classified as accurate than the likelihood ratios from the other two information classes. It is difficult to reject the null hypotheses for the remaining three financial ratios.

Three years. The results for the time period three years prior to bankruptcy are presented in Table 15. The null hypothesis can be rejected for two of the financial ratios, owner's equity/total debt and current assets/current liabilities. The financial ratio owner's equity/total debt yields the highest percentage of accurate revisions when presented on a current cost basis. The financial ratio current assets/current liabilities was classified as accurate most frequently when the information was presented on a historical cost basis. It is difficult to reject the null hypotheses for the other two financial ratios.

One year. The results of Cochran's Q for the time period one year prior to bankruptcy are presented in Table 16. The null hypothesis can be rejected for the financial ratio net income/total assets. A significantly higher proportion of the likelihood odds ratios caused revision in the proper direction when the information was presented on a current-cost basis. It is difficult to reject the nulls for the other three financial ratios.

Table 14

Accuracy and Inaccuracy Percentages, Cochran's Q and Level of Significance for Both Time Periods Combined

Financial Ratio/Information Class	Historical Cost - %	Current-Cost - %	Both H.C. & C.C. %	Cochrans Q	Level of Significance
Owner's Equity/Total Debt					
Accurate	55	62	55	4.5629	.1021
Inaccurate	45	38	45		
Net Income/Total Assets					
Accurate	59	65	62	3.1736	.2046
Inaccurate	41	35	38		
Current Assets/Total Assets					
Accurate	30	32	34		
Inaccuarte	70	68	66	1.6494	.4384
Current Assets/Current Liabilities					
Accurate	47	46	42		
Inaccurate	53	54	58	2.5190	.2838

Table 15

Accuracy and Inaccuracy Percentages, Cochran's Q and Level of Significance for Three Years Prior to Bankruptcy

Financial Ratio/Information Class	Historical Cost - %	Current-Cost - %	Both H.C. & C.C. %	Cochrans Q	Level of Significance
Owner's Equity/Total Debt					
Accurate	42	58	47	9.2381	.0099
Inaccurate	58	42	53		
Net Income/Total Assets					
Accurate	69	72	74		
Inaccurate	31	28	26	1.4769	.4788
Current Assets/Total Assets					
Accurate	35	33	35		
Inaccurate	65	67	65	.3611	.8348
Current Assets/Current Liabilities					
Accurate	55	48	40		
Inaccurate	45	52	60	7.1183	.0285

Table 16

Accuracy and Inaccuracy Percentages, Cochran's Q and Level of Significance for One Year Prior to Bankruptcy

Financial Ratio/Information Class	Historical Cost - %	Current-Cost - %	Both H.C. & C.C. %	Cochrans Q	Level of Significance
Owner's Equity/Total Debt					
Accurate	68	66	63		
Inaccurate	32	34	37	.8916	.6403
Net Income/Total Assets					
Accurate	50	58	50		
Inaccurate	50	42	50	5.1429	.0764
Current Assets/Total Assets					
Accurate	24	31	33		
Inaccurate	76	69	67	2.8537	.2401
Current Assets/Current Liabilities					
Accurate	39	44	43		
Inaccurate	61	56	57	1.6000	.4493

Discussion. The results of this section tend to support the results of the other statistical tests, there is a significant difference between information classes on the impact to the user that a particular financial ratio has. The financial ratios owner's equity/total debt and net income/total assets appear to be most useful for the prediction of bankruptcy when measured on a current-cost basis. The financial ratio current assets/current liabilities seems to provide the most useful information when measured on historical costs. Again, there seems to be no difference for the financial ratio current assets/total assets.

Conclusion

The results of the data analysis indicate that there are significant differences in the information content that the three information classes convey to the user. The effect of the information class is conditional upon the financial ratio through which it is being reflected and the firm for which the information is being presented. The tests suggest that for two financial ratios, owner's equity/total debt and net income/total assets, that more useful information for predicting bankruptcy is conveyed when the ratios are presented on a current cost basis, either alone or as supplemental information. The financial ratio current assets/current liabilities appears to convey the most useful information when presented on a historical cost basis. The concluding chapter discusses limitations and implications of these results.

FOOTNOTES

[1]For this part of the analysis, the odds ratios for nonbankrupt firms were inverted so that likelihood ratios greater than one would be accurate in direction for all firms.

[2]Sidney Sigel, Nonparametric Statistics for the Behavioral Sciences, (New York: McGraw-Hill Book Company, 1956), pp. 166-172.

[3]Ibid., pp. 161-166.

CHAPTER VI

CONCLUSION

Limitations of the Study

The interpretation of the results of this study will have to be qualified for a number of reasons. First, the definition of failure that was used in this study is only one of many possible definitions of failure. A different definition, such as bond default or nonpayment of a preferred dividend may produce results that are different from this study.

The independent variables used in this study do not encompass all of the decision variables that enter into to a failure evaluation. The inclusion of other relevant variables or different financial ratios might yield different results.

Another qualification relates to the reasonableness of the current-cost adjustments. Actual current-costs were not available which necessitated the use of specific price indices for estimating the current-costs. Also, the FIFO assumption was used to determine the age structure for existing assets of a firm, this may not yield accurate results. The accuracy of the current-cost data depends upon the reasonableness of these estimating procedures. Precedent for these methods does exist in the literature however.[1,2,3,4]

The ratio of bankrupt to nonbankrupt firms was one to one which differs from real proportions. The results might be different if a different proportion of failed to nonfailed firms were used. The interaction effect between firm and information class, and the significant firm effect indicate that the results might be different were another selection of firms to be made. The difference in age and asset structure of firms will have differing effects upon the numerical value of the current-cost financial ratio. This could result in differing impacts upon the subjective probability judgments of the users of current-cost financial information. Theoretically, since the industry, firms, and the participants were not randomly selected, the results cannot be generalized to other settings.

The results obtained in this study may or may not be stable over time. Loan officers and credit analysts currently deal with ratios prepared from historical cost financial statements, their experience with current-cost financial ratios may be limited or nonexistent. There may be a learning curve effect as the bankers become more familiar with the current-cost concepts and their numerical values. Norms currently exist for ratios in various industries, so that a point of reference exists for the analysis of ratios prepared from historical cost information. There is a question as to whether an appropriate reference point has been established for current-cost ratios that makes their evaluation meaningful. Are the loan officers interpreting the current-cost ratios in a historical cost framework, or have they made adjustments in their decision process? Studies of this nature need to be repeated as bankers and other accounting data users become more familiar and experienced with the current-cost concept to test for a learning curve effect.

Interpretation and Implications of the Results

The results of the statistical tests described in chapter five indicate that the three information classes do have different impacts upon the users of the financial information. It is difficult to say which information class provides superior or the best information for predicting bankruptcy since the effect of the three information classes differs between financial ratios. The current-cost information appears to convey the most useful information when reflected through the financial ratios owner's equity/ total debt and net income/ total assets. The historical cost information appears to convey the most information when reflected through the financial ratio current assets/ current liabilities.

The statistically significant differences and the direction of the differences between the information classes implies that there may be some merit in requiring replacement cost financial reporting as either sole or supplemental disclosure. The firm and financial ratio effects indicate however that further research is necessary before the controversy can be settled. Decisions other than the prediction of bankruptcy utilize financial information and current-cost information could affect these decisions also. Therefore, further empirical investigation is necessary before classifying one of the information alternatives as the best information for financial users.

Summary and Conclusions

The purpose of this study was to examine the effects of alternative information classes on users' decisions. This study is an addition to the published research that utilizes the methodology and the findings of behavioral decision theory and Bayesian human information processing. Other research in the area includes Barefield, 1972; Dickhaut, 1973; Ronen, 1971; and Kennedy, 1975. Ronen experimented in sequential aggregation on the subjective expected utility model of decision making. Barefield investigated the effects of the use of aggregated and disaggregated accounting reports. Dickhaut investigated methodological issues related to the design of behavioral research and the usefulness of accounting information. Kennedy used Bayes' theorem to study the impact and usefulness of accounting ratios in the prediction of bankruptcy.

In this study the dependent variable was the likelihood odds ratio which was obtained from the odds form of Bayes' theorem. The likelihood odds ratio was used to measure the relative impact of four financial ratios presented under three information class alternatives. The description of user reactions to the alternative information structures can contribute to the setting of accounting policies. The results of this research can aid in the analysis of whether or not current-cost information will be useful to decision makers.

The impact of accounting alternatives upon users' decisions is an important factor in accounting policy setting. The methodology and human information processing model used in this study demonstrate a way in which accounting alternatives can be evaluated as to their differing effects upon users' decisions. This methodology can also be applied to other items or sets of items of information and can be used to assist in resolving some accounting controversies such as fifo versus lifo inventory valuation, differing depreciation methods, lease capitalization, and full or direct costing. It is expected that as more accounting researchers become aware of the human information processing models being developed in the behavioral sciences that more research of this type will be done.

FOOTNOTES

[1] Harold Bierman, "The Effect of Inflation on the Computation of Income of Public Utilities," The Accounting Review, (April 1956), pp. 258-262

[2] George H. Warner, "Depreciation on a Current-Cost Basis," The Accounting Review, (October 1954), pp. 628-633.

[3] Werner Frank, "A Study of the Predictive Significance of Two Income Measures," Journal of Accounting Research, (Spring 1969), pp. 123-136.

[4] Edward V. McIntyre, "Current-Cost Financial Statements and Common-Stock Investments Decisions," The Accounting Review, (July 1973), pp. 575-585.

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APPENDIX A

HISTORICAL COST TO CURRENT-COST ADJUSTMENT PROCEDURES

Introduction

In Accounting Series Release No 190/March 23, 1976, the SEC required the disclosure of the estimated current replacement cost of inventories and productive capacity at the end of each fiscal year for which a balance sheet is required and the approximate cost of sales and depreciation based on the replacement cost of the firm's assets. In arriving at the current-cost figures used in this study, the SEC guidelines set forth in ASR No 190 will be followed. The replacement cost data will be estimated by the procedures set forth in this appendix. These replacement cost figures will then be substituted for their historical cost counterparts to arrive at the current-cost figures to be used in the current-cost financial ratios. In ASR 190, the procedures to be used in arriving at replacement cost figures are left to the discretion of the statement preparers. The SEC was critisized for the absence of a definition of replacement cost so a definition was provided in Staff Accounting Bulletin (SAB) No. 7:

> Replacement cost is the lowest amount that would have to be paid in the normal course of business to obtain a new asset of equivalent operating or productive capability. In the case of depreciable, depletable or amortizable assets, replacement cost (new) and depreciated replacement cost should be distinguished...

Staff Accounting Bulletin (SAB) No. 10 listed four types of replacement cost measures:

1. Indexing - i.e. applying a specific index to an acquisition cost.
2. Direct pricing - i.e. using current factor prices to build up the cost of the asset.
3. Unit pricing - i.e. identifying the appropriate unit of measure of the asset in question (such as square feet of a building) and multiplying by their current prices.
4. Functional pricing - i.e. identifying the output of a process and developing a current-cost to create capacity to produce that output.

The methodology used to approximate the current-costs in this study was by indexing. Direct measures of the replacement values of inventories and depreciable assets were not available; therefore, surrogate measures were used. Inventory values were obtained by applying the specific Wholesale Price Index appropriate for the particular industry to the historical cost inventories. The Implicit Price Deflator for the Nonresidential Business Investment Component of Gross National Product was used to make the adjustments to depreciable assets. There is support in the literature for using specific price indices to obtain surrogate measures for replacement cost values (McIntyre, 1973; Frank, 1970; Warner, 1954; and Brooks and Buckmaster, 1975). Although there have been no empirical tests to date, use of specific price indices should yield good estimates of replacement costs.

Property, Plant and Equipment, Accumulated Depreciation and Depreciation Expense

This section explains the computational procedures used in estimating the current cost of Property, Plant and Equipment (PP&E), the related Accumulated Depreciation and the Depreciation Expense.

I. The first step is the construction of an aged schedule of PP&E. An aged schedule shows the original cost of PP&E by year of acquisition. This is necessary so that the appropriate price indices can be applied to asset balances when making the conversion from historical cost to current-cost. An assumption is made when constructing an aged schedule that PP&E was used and disposed of on a first-in, first-out basis (FIFO). The steps taken to prepare an aged schedule of PP&E follow.

1. Obtain the ending balance of PP&E and the annual capital expenditures from the COMPUSTAT tapes or from the form 10-K for years going back 15 years before the desired year of financial statements, (k-15),(k).
2. An assumption about the acquisition of PP&E on hand at the period 15 years before the desired financial statements will have to be made. The assumption will be made that all PP&E on hand at that date was acquired Y years earlier. Y is one-half the reciprocal of the firm's k-15 composite depreciation rate, (R).

$$R = \frac{\text{Year k-15 Depreciation Expense}}{\text{Historical cost of year k-15 ending balance of PP\&E}}$$

$$Y = \tfrac{1}{2} \cdot R$$

This makes the estimated date of acquisition of the beginning balance of PP&E for year k-15 equal to year k-15-Y. If a firm is less than 15 years old this procedure will not be necessary, since the beginning balance and the date of acquisition will be known.

3. A schedule can now be prepared showing acquisitions and disposals of PP&E for the year k-15 to the desired year. The beginning balance and ending balance of PP&E and capital expenditures will be taken from the COMPUSTAT tapes or the 10-k's and set in the following schedule:

SCHEDULE OF ACQUISITIONS AND DISPOSALS

Year of Acquisition	Beginning Balance	+	Acquisitions	-	Disposals	=	Ending Balance
k-15-Y	0		ACQ_{k-15-Y}		DIS_{k-15-Y}		EB_{k-15-Y}
k-15	BB_{k-15}		ACQ_{k-15}		DIS_{k-15}		EB_{k-15}
k-14	BB_{k-14}		ACQ_{k-14}		DIS_{k-14}		EB_{k-14}
⋮	⋮		⋮		⋮		⋮
Desired Year K*	BB_k		ACQ_k		DIS_k		EB_k

*For a failed firm, the desired year will be the year prior to bankruptcy and three years prior to bankruptcy.

4. The Schedule of Acquisitions and Disposals can then be used to construct an Aged Schedule of PP&E for any year. Start with the latest acquisition and go up the acquisition column until the total equals the ending balance of PP&E for the desired year, k.

$$EB_k = ACQ_k + ACQ_{k-1} + ACQ_{k-2} + \cdot \cdot \cdot + ACQ_{k-t}$$

For any year, the balance in PP&E can now be broken down by the amount and year of acquisition. This schedule will have to be prepared for each year that the financial ratios are to be computed.

II. The current-cost of PP&E can now be estimated for any year by the use of specific price indices for PP&E. The Price indices for PP&E came from the appropriate year from the Implicit Price Deflator for the Nonresidentail Business Investment Component of Gross National Product. Each year's layer was multiplied by the appropriate conversion factor and then summed. The appropriate conversion factor to convert from year t to the desired year k is:

$$\text{Conversion Factor} = \frac{\text{Price index for year k}}{\text{Price index for year t}}$$

The current-cost of PP&E for year k is then:

$$\begin{array}{l}\text{Current-cost of} \\ \text{PP\&E for year k}\end{array} = \sum_{t=i}^{k} (ACQ_t)(\text{ conversion factor year t})$$

where i is the earliest layer of acquisition used in the aged schedule for arriving at the ending balance of PP&E for year k.

A hypothetical example follows to illustrate these procedures. The hypothetical firm was established in 1972, and the following data was obtained from the firm's 10-K report:

Year	Beginning Balance PP&E	Acquisitions	Ending Balance PP&E
1972	$ 0	$300,000	$ 300,000
1973	300,000	500,000	750,000
1974	750,000	250,000	900,000
1975	900,000	300,000	1,100,000
1976	1,100,000	300,000	1,150,000
1977	1,150,000	200,000	1,200,000

The following price indices were selected from the Implicit Price Deflator for the Nonresidential Business Investment Component of Gross National Product for the years 1972-1977.:

Year	Price Index
1972	1.30
1973	1.37
1974	1.42
1975	1.75
1976	1.87
1977	1.95

The next step in the computation of the current-cost of PP&E for 1977 is the construction of an aged schedule of PP&E. The desired ending balance for PP&E in 1977 is $1,200,000. Working backwards through the acquisition column yields the aged schedule showing the balance in PP&E by amount and year of acquisition.

Year of Acquisition	Amount	Sum
1977	$200,000	$ 200,000
1976	300,000	500,000
1975	300,000	800,000
1974	250,000	1,050,000
1973*	150,000	1,200,000

* Only part of the 1973 acquisition is used so that the desired 1977 balance of $1,200,000 is obtained.

The next step is to convert the aged schedule of PP&E to current-costs by multiplying by the appropriate conversion factor and summing. Using the aged schedule prepared above and the price indices given earlier yields:

Year of Acquisition	Historical Amount	Conversion Factor	1977 Current-Cost
1977	$200,000	$\frac{1.95}{1.95}$	$ 200,000
1976	300,000	$\frac{1.95}{1.87}$	312,834
1975	300,000	$\frac{1.95}{1.75}$	334,286
1974	250,000	$\frac{1.95}{1.42}$	343,310
1973	150,000	$\frac{1.95}{1.37}$	213,505
			$ 1,403,935

The $1,403,935 represents the current-cost of PP&E for 1977, its historical cost was the $1,200,000.

III. Now that the balances in PP&E are stated on a current-cost basis, an estimate of current-cost depreciation expense for any year can be computed. The steps are as follows.

1. Compute the composite depreciation rate for year t, R_t.

$$R_t = \frac{\text{Depreciation expense for year t}}{\text{Average historical cost of PP\&E for year t}}$$

where the average historical cost of PP&E for year t is: $(\frac{1}{2})\ (BB_t + EB_t)$. BB_t and EB_t are the beginning and ending balance of PP&E for year t.

2. Multiply the composite depreciation rate times the average current-cost balance of PP&E for year t.

$$\begin{array}{l}\text{Current-cost}\\ \text{Depreciation}\\ \text{for Year t.}\end{array} = R_t \cdot \begin{array}{l}\text{Average current-cost}\\ \text{balance of PP\&E for}\\ \text{year t}\end{array}$$

where the average current-cost of PP&E for year t is: $(\frac{1}{2})(\text{Current-cost } BB_t + \text{Current-cost } EB_t)$.

IV. The current-cost accumulated depreciation can be computed in a manner similar to the computation of current-cost depreciation expense.

1. Compute the accumulated depreciation rate for year t, ADR_t.

$$ADR_t = \frac{\text{Accumulated depreciation at end of year t}}{\text{Ending balance of PP\&E for year t}}$$

2. Multiply the historical cost accumulated depreciation rate for year t, ADR_t, times the ending current-cost balance of PP&E for year t. This yields what current-cost accumulated depreciation should be at the end of year t.

$$\text{Current-cost Accumulated Depreciation} = (ADR_t)\ (\text{Current-cost } EB_t)$$

where current-cost EB_t is the current-cost ending balance of PP&E for year t.

An extension of the earlier example follows to illustrate these procedures. The additional information needed from the 10-K report is:

Year	Depreciation Expense	Accumulated Depreciation
1977	$112,500	$345,000

Using the procedures to calculate the current-cost of PP&E, the beginning balance of PP&E for 1977 is $1,359,285.

First, compute the composite depreciation rate for 1977, R_{1977}.

$$R_{1977} = \frac{\$112,500}{(\frac{1}{2})(\$1,050,000 + 1,200,000)} = .10$$

Next, compute the current-cost depreciation expense for 1977 by multiplying the composite depreciation rate times the average current-cost balance in PP&E for 1977

$$\text{Current-cost Depreciation Expense for 1977} = (.10)(\$1,359,285 + 1,403,935)(\tfrac{1}{2})$$
$$= \underline{\underline{\$138,160}}$$

The accumulated depreciation rate for 1977, ADR_{1977}, is:

$$ADR_{1977} = \frac{\$345,000}{\$1,200,000} = .2875$$

The current-cost accumulated depreciation for 1977 can now be computed by multiplying the accumulated depreciation rate times the ending current-cost balance in PP&E for 1977.

$$\text{Current-cost Accumulated Depreciation for 1977} = (.2875)(\$1{,}403{,}935) = \underline{\underline{\$403{,}630}}$$

Inventories and Cost of Goods Sold

Since the assumed time of acquisition of FIFO, LIFO and average inventory methods affects results, three adjustment procedures were necessary for inventories and the related cost of goods sold.

I. FIFO Inventories.

1. The first step in the computation of the current-cost of inventory under FIFO inventory procedures is the computation of inventory purchases made during the year:

$$\text{Purchases} = EI_t + CoGS_t - BI_t$$

where EI_t is the reported ending inventory,

$CoGS_t$ is the reported cost of goods sold, and

BI_t is the reported beginning inventory.

2. Next, compute the inventory turnover for the year:

$$\text{Turnover} = \frac{CoGS_t}{(\frac{1}{2})(BI_t + EI_t)} = n \text{ times per year.}$$

There are n inventory holding periods (IHP) during the year of length T= 12/n months.

3. Assume that purchases are made at an even rate throughout the year, the average purchases for each inventory holding period is then:

$$\text{Average Purchase during } IHP_n = \frac{CoGS_t - BI_t}{n-1}$$

4. Compute average index prices for each of the n inventory holding periods, using the price indices from the months during the holding periods:

$$AN_i = \sum_{j=1}^{T-1} \frac{NM_{(12-j)}}{T}$$

where NM_j is the index number for the i^{th} month in the turnover period, and AN_i is the average price index for holding period i.

The indices were selected from the specific Wholesale Price Index appropriate for the particular industry.

5. Assuming that purchases are made n times per year at an even rate and that the reported ending inventory is the last set of purchases, assumed purchased at the average price during the last (n^{th}) period, cost of goods sold is therefore beginning inventory plus the first n-1 set of purchases. The current-cost of ending inventory is then computed by multiplying the reported ending inventory by the appropriate indices, i.e., the index number at year end over the average index prevalent during the last inventory holding period.

$$\text{Current-cost } EI_t = (EI_t)\left(\frac{\text{NM at year end}}{AN_n}\right)$$

6. To estimate the current-cost of cost of goods sold, assume that inventories are sold in the period after they are purchased (the FIFO assumption). Layer the reported cost of goods sold by beginning inventory and the first n-1 set of purchases.

$$\begin{matrix}\text{Historical Cost} \\ \text{CoGS}\end{matrix} = BI + \text{Purchases } IHP_1 + \text{Purchases } IHP_2 + \cdots + \text{Purchases } IHP_{n-1}$$

Multiply the layers by the appropriate conversion factor and sum. The appropriate conversion factor for layer i is:

$$\begin{matrix}\text{Conversion} \\ \text{Factor}_i\end{matrix} = \frac{AN_i}{AN_{i-1}}$$

where AN_i is the average index for inventory holding period i which was computed earlier.

$$\begin{matrix}\text{Current-cost} \\ \text{CoGS}\end{matrix} = (BI_t)\left(\frac{AN_1}{AN_0}\right) + \sum_{i=1}^{n-1} (\text{Purchase}_i)\left(\frac{AN_{i+1}}{AN_i}\right)$$

where AN_0 is the index value of the last inventory holding period of the preceding fiscal year. Purchase_i represents the average purchase during IHP_n.

II. LIFO Inventories.

1. For LIFO adjustments, the primary problem was to acquire a series of acquisition dates for the LIFO layers. Starting with the date LIFO was adopted, construct the LIFO inventory by layers added and subtracted, beginning with the base inventory at year of adoption. The base layer is the entire balance in the year of adoption and annual layers are added or subtracted to five a schedule of inventory layers by year of acquisition.

$$\text{LIFO Inventory} = \text{Base} + \text{layer}_1 + \text{layer}_2 + \cdots + \text{layer}_m$$

where layer_m is the layer added during year m.

2. For the years that financial statements are needed, convert the beginning and the ending inventories to current-costs by multiplying the layers by the appropriate relative indices:

$$\begin{array}{c}\text{Current-cost}\\ \text{Inventory}\end{array} = \sum_{i=1}^{n} (\text{layer}_i)\left(\frac{\text{desired year index}}{\text{average index for year i}}\right)$$

For ending inventory adjustments, the desired index is the end of the year index, while for beginning inventories, the index is the beginning of the year index. The average index for year i is the average index for the year during which the layer was acquired.

3. Compute the purchases for the year:

$$\text{Purchases} = EI_t + CoGS_t - BI_t$$

4. Compute the current-cost of cost of goods sold by using the adjusted inventory figures.

$$\begin{matrix}\text{Current-cost} \\ \text{CoGS}\end{matrix} = \begin{matrix}\text{Current-cost} \\ \text{BI}\end{matrix} + \text{Purchases} - \begin{matrix}\text{Current-} \\ \text{cost EI}\end{matrix}$$

III. <u>Average inventories.</u>

1. The method used to adjust average cost inventories is based upon the assumption that the ending inventory of a year reflects the average prices for that year. Ending inventories can be adjusted to current-cost by multiplying the reported ending inventory times the appropriate relative indices:

$$\begin{matrix}\text{Current-cost} \\ \text{Ending} \\ \text{Inventory}\end{matrix} = (EI_t)\left(\frac{\text{End of year index}}{\text{Average index for the year}}\right)$$

2. To compute the estimated current-cost of cost of goods sold, determine the historical cost of goods available for sale, GAS_{hc}:

$$GAS_{hc} = BI_t + \text{Purchases}_t$$

3. Compute an average mix of historical cost of goods sold, $CoGS_{hc}$, to historical cost of goods available for sale.

$$\text{Average Mix} = \frac{CoGS_{hc}}{GAS_{hc}}$$

4. Compute the current-cost of goods availabe for sale, GAS_{cc}, by converting beginning inventory and purchases to end of year prices:

$$\text{Current-cost BI} = (BI_t)\left(\frac{\text{End of year index}}{\text{Beginning of year index}}\right)$$

$$\text{Current-cost of Purchases} = (\text{Purchases})\left(\frac{\text{End of year index}}{\text{Average index for year}}\right)$$

$$GAS_{cc} = \text{Current-cost BI} + \text{Current-cost of purchases}$$

5. To estimate the current-cost of cost of goods sold, multiply the average mix times the current-cost of goods available for sale:

$$\text{Current-cost CoGS} = (GAS_{cc})\left(\frac{CoGS_{hc}}{GAS_{hc}}\right)$$

The current-cost figures estimated by the procedures set forth in the preceding discussion were then substituted for their historical cost counterparts to arrive at the current-cost figures used in the current-cost financial ratios.

APPENDIX B

QUESTIONNAIRE

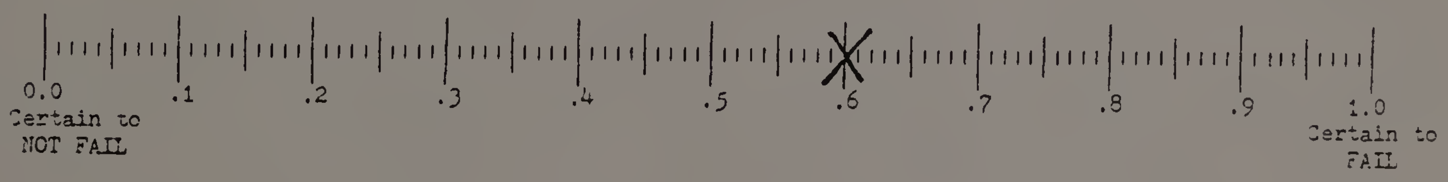
THE RELATIVE INFORMATION CONTENT OF CURRENT-COST VS. HISTORICAL COST FINANCIAL RATIOS IN PREDICTING BUSINESS FAILURES

Gary S. Monroe
University of Massachusetts
Amherst, Massachusetts

GENERAL DIRECTIONS

Six manufacturing firms are presented in the questionnaire. Three of the firms eventually went bankrupt and three of the firms are still going concerns. For each of the firms, the total asset size and four financial ratios are presented. The information for each firm is presented three times for each year, once for each of three information classes. The three information classes are: (1) Conventional accounting (historical cost), (2) Replacement cost accounting (current-cost), and (3) Both historical cost and current-cost presented together. You are asked to estimate the probability that a firm will go bankrupt after viewing each piece of financial information. Therefore, for each firm you are asked to make five (5) probability judgments within each information class, one after viewing the total asset size and one for each of the four financial ratios.

Please indicate your probability judgment by placing an X in the appropriate spot on the 100 point scale below each piece of financial information. For example, suppose that after viewing the ratio owner's equity to total debt for firm number 1 you feel that the probability that the firm will fail is .6 (or a 60% chance), place an X like such:



Placing an X on 1.0 means that you feel that the firm is certain to fail. Placing an X on 0.0 indicates that you feel that the firm is certain to NOT fail. Making a probability judgment of failure also indicates a judgment of nonfailure, i.e., making the judgment of .6 also indicates that the probability of nonfailure is .4. The responses that you are making are subjective in nature, there is no right or wrong answer. Your estimate is the correct response.

The financial ratios have been computed from financial statements from two different time periods, i.e., one year before the failed firms became bankrupt and three years before the failed firms became bankrupt. The ratios for the nonbankrupt firms were prepared from financial statements from the same time periods as the failed firms. The time period from when the financial ratios were prepared is indicated at the beginning of each set of firms and their ratios.

While filling out the questionnaire, please do one firm at a time within a set of firms. Each firm contains five (5) slips of paper with the financial information and the 100 point scale printed on them. There are six firms within a set. Complete the firm at the top of the page and move down to the next firm in the set after making the five judgments. After completing a set of firms, please turn the yellow sheet and read the conditions for the next set of firms.

I realize that this is not how you normally analyze financial ratios, i.e., one at a time with individual probability judgments and that many other factors are involved. However this format is necessary in order to measure the effect of the three information classes on each ratio individually. Thank you for bearing with me in this task. Your participation is greatly appreciated and may significantly influence policy decisions as to whether or not replacement cost information should be required reporting for all firms.

The Current-Cost Ratios

The financial ratios that have been prepared from replacement cost financial statements follow the guidelines set forth in ASR/190 put out by the SEC. Inventories and property, plant and equipment have been recorded at their replacement values. These replacement cost figures were used in computing the current-cost financial ratios. In computing replacement cost income, replacement cost depreciation and cost of goods sold were substituted for their historical cost counterparts.

INSTRUCTIONS

This set of financial ratios has been computed from financial statements that were prepared on a current-cost basis, similar to the required reporting by the SEC in ASR/190. The financial ratios were computed from statements three years prior to the year that the failed firms actually failed. Please make your probability judgments within this time frame, i.e., the probability that the firms will fail within three years.

Firm No. 006

Firm No. 067

Firm No. 038

Firm No. 040

Firm No. 084

Firm No. 069

Total Assets = $537,198

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

Total Assets = $12,932,320

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

Total Assets = $3,590,120

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

Total Assets = $1,298,160

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

Total Assets = $3,331,540

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

Total Assets = $1,570,850

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Current Assets}}{\text{Current Liabilities}} = 2.12$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Owner's Equity}}{\text{Total Debt}} = .407$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Owner's Equity}}{\text{Total Debt}} = .621$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Net Income}}{\text{Total Assets}} = .037$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Owner's Equity}}{\text{Total Debt}} = .825$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Owner's Equity}}{\text{Total Debt}} = .720$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Net Income}}{\text{Total Assets}} = .208$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Current Assets}}{\text{Current Liabilities}} = 1.40$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Net Income}}{\text{Total Assets}} = -.131$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Current Assets}}{\text{Current Liabilities}} = 12.87$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Current Assets}}{\text{Current Liabilities}} = 1.68$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$$\frac{\text{Current Assets}}{\text{Total Assets}} = .720$$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$\frac{\text{Current Assets}}{\text{Total Assets}} = .729$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$\frac{\text{Current Assets}}{\text{Total Assets}} = .867$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$\frac{\text{Current Assets}}{\text{Current Liabilities}} = .361$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$\frac{\text{Current Assets}}{\text{Total Assets}} = .767$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$\frac{\text{Net Income}}{\text{Total Assets}} = .255$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

$\frac{\text{Net Income}}{\text{Total Assets}} = -.086$

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Certain to NOT FAIL — Certain to FAIL

Please move down and complete the next firm.

Please move down and complete the next firm.

Please move down and complete the next firm.

Please move down and complete the next firm.

Please move down and complete the next firm.

Please turn the page and read the instructions
for the next set of firms.

INSTRUCTIONS

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INSTRUCTIONS

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INSTRUCTIONS

This set of financial ratios has been computed from financial statements that were prepared on both current-cost and historical cost bases. The ratios from the different bases are identified for all the firms. The financial ratios were computed from statements one year prior to the year that the failed firms actually failed. Please make your probability judgments within this time frame, i.e., the probability that the firms will fail within one year.