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for the first three years prior to bankruptcy, additional research is needed to compare the predictive abilities of GPL, CC and HC financial ratios for more than three years prior to bankruptcy. Fourth, in this study bankruptcy prediction models are derived from financial ratios only. Other variables could be added to the model such as size of firms, management competence, and other economic factors. Fifth, since the findings of this research are restricted to matched-pair design, an additional investigation is needed to compare the predictive ability of GPL, CC and HC financial ratios under different research designs. Finally, the research methodology of this study can be used on different area of research such as predicting bond rating changes, or performing versus non-performing bank loans.

Table 7: Comparison of Predictive Accuracy of HC/GPL and HC/CC Models

Year	HC/GPL Correct Prediction		HC/CC Correct Prediction		Computed Chi Square
	B	N	B	N	
1	21/26	22/26	25/26	26/26	7.08r
overall	82.69%		98.08%		
2	22/26	20/26	25/26	25/26	6.03r
Overall	80.77%		96.15%		
3	20/26	20/26	25/26	24/26	5.67r
overall	76.92%		94.23%		

B - Bankrupt N - Non-Bankrupt r - Reject at Alpha 5%

5. CONCLUSIONS AND RECOMMENDATIONS

Several conclusions can be drawn from this study. First, the three information systems HC, GPL and CC are equally useful for predicting the firms used in this study as bankrupt or non-bankrupt. Second, the combined HC/CC model shows superior results over the HC model, and the combined HC/GPL model. Third, the findings of this study support the results of Aly's study [1992] which indicate that the combined historical cost and current cost model has more discriminant power than does the historical cost model alone in each of the three years before bankruptcy.

One limitation of the study is that the results of this study apply only to large bankrupt firms and may not extend to the population of all bankrupt firms. Second, this study includes only periods of high inflation. Therefore, the ability of the alternative prediction models to predict bankruptcy should be tested for periods with differing inflation rates.

Several suggestions for future research can be made from this study. First, no attempt has been made to compare the costs of GPL or CC disclosures with the benefits obtained from this information, additional research may be useful in this area. Second, since the study is limited to industrial firms, an extension of the study to non-industrial firms may lead to different conclusions and might also provide a larger population for failed firms from which to select a sample. Third, since the analyses of this study are made

4. **The HC model versus the combined HC/CC model**. The data in **Table 6** reveals that when HC information is combined with CC information in a single model, the resulting model outperforms the HC model in predicting bankrupt and non-bankrupt firms. The overall prediction results are 98.08 percent in year one, 96.15 percent in year two and 94.23 percent in year three before bankruptcy. Chi-square tests in **Table 6** indicate that the differences in predictive power are significant in each of the three years before bankruptcy at **Alpha 5%.**

Table 6: Comparison of Predictive Accuracy of HC and HC/CC Models

Year	HC Correct Prediction		HC/CC Correct Prediction		Computed Chi Square
	B	N	B	N	
1	21/26	20/26	25/26	26/26	9.42r
overall	78.85%		98.08%		
2	21/26	19/26	25/26	25/26	8.25r
Overall	76.92%		96.15%		
3	19/26	20/26	25/26	24/26	7.39r
overall	75.00%		94.23%		

B - Bankrupt N - Non-bankrupt r - Reject at Alpha 0.05

5. **The combined HC/GPL model versus the combined HC.CC model**. In comparing the performance of the model combining HC and GPL information to the model combining HC and CC information, the results in **Table 7** reveal that the combined HC/CC model produces a superior overall prediction rate to the combined HC/GPL in each of the three years before bankruptcy. The overall prediction results are 98.08 percent versus 82.69 percent in year one, 96.15 percent versus 80.77 percent in year two, and 94.23 percent versus 76.92 percent in year three prior to bankruptcy. The differences in predicting power are significant in each of the three years before failure at **alpha 5%** as indicated by Chi-square results.

Table 4: Comparison of Predictive Accuracy of HC and HC/GPL Models

Year	HC Correct Prediction		HC/GPL Correct Prediction		Computed Chi Square
	B	N	B	N	
1	21/26	20/26	21/26	22/26	0.25
overall	78.85%		82.69%		
2	21/26	19/26	22/26	20/26	0.23
Overall	76.92%		80.77%		
3	19/26	20/26	20/26	20/26	0.05
overall	75.00%		76.92%		

B - Bankrupt N - Non-Bankrupt

3. **The HC model versus the CC model**. The data in **Table 5** presents a comparison between the HC model and the CC model in predicting bankrupt firms from non-bankrupt firms. The results reveal that there are no significant differences in the prediction rate of the tow models in the three years before bankruptcy. The overall percentages of correct prediction of the CC model are 75.00 percent in the first year, 78.85 percent in the second year, and 80.77 percent in the third year prior to bankruptcy.

Table 5: Comparison of Predictive Accuracy of HC and CC Models

Year	HC Correct Prediction		CC Correct Prediction		Computed Chi Square
	B	N	B	N	
1	21/26	20/26	20/26	19/26	0.22
overall	78.85%		75.00%		
2	21/26	19/26	21/26	20/26	0.06
Overall	76.92%		78.85%		
3	19/26	20/26	21/26	21/26	0.50
overall	75.00%		80.77%		

B - Bankrupt N - Non-bankrupt

Prediction Results

1. **The HC model versus the GPL model.** The data in **Table 3** presents a comparison of the ability of the HC model and the GPL to predict bankrupt firms from non-bankrupt firms. The results indicate that the HC model produces better prediction rate in year one prior to bankruptcy than it does in year two and year three 978.850 percent in year one, 76.92 percent in year two and 75 percent in year three). The results also indicate that the GPL model produces better prediction rate in year two prior to bankruptcy than it does in year one and year three (78.85 percent in year two, 76.92 percent in year one, and 73.08 percent in year three). However, Chi-square tests indicate that there are no significant differences in the overall percentages of correct prediction derived form the two models in each of the three years before bankruptcy.

Table 3: Comparison of Predictive Accuracy of HC and GPL Models

Year	HC Correct Prediction		GPL Correct Prediction		Computed Chi Square
	B	N	B	N	
1	21/26	20/26	22/26	18/26	0.06
overall	78.85%		76.92%		
2	21/26	19/26	20/26	21/26	0.06
Overall	76.92%		78.85%		
3	19/26	20/26	19/26	19/26	0.05
overall	75.00%		73.08%		

B - Bankrupt N - Non-Bankrupt

2. **The HC model versus the combined HC/GPL model.** The data in Table 4 reveals that when HC information is combined with GPL information in a single model, it outperforms the HC model in predicting bankrupt and non-bankrupt firms, The overall percentages of correct prediction of the combined HC/GPL model are 82.69 percent in year one, 80.77 percent in year two, and 76.92 percent in year three prior to bankruptcy. Chi square tests in **Table 4** show that the differences in predictive power of the two models are not significant in any of the three years before bankruptcy.

ratios computed with both HC and CC information. This procedure is repeated for the three time periods: one, two, and three years prior to bankruptcy.

A backward elimination selection method is used in developing the five discriminant functions. Although the stepwise method is used in several studies of bankruptcy, such as Norton and Smith [1979], and Mensah [1983], this method does not examine the worth of a group of variables which individually may not be statistically significant but as a group are highly significant. Backward elimination overcomes this deficiency. The selection criterion is the minimization of Wilk's Lambada for all three of the discriminant functions. Norton and Smith [1979] and Mensah [1983] and many other studies used this method of selection.

To determine whether a significant difference exists in the ability of the five models to predict bankrupt and non-bankrupt firms, a Lachenbruch holdout method is applied to test whether the difference in the predictive accuracy between any two models is significant. Under the Lachenbruch holdout method, [SPSSX, 1983], the overall percentage of correct Prediction is calculated by holding out one observation at a time, deriving the discriminant function based on the remaining observations (N-1), and applying the resulting discriminant function to predict the held-out observation. The procedure is repeated until all of the observations are predicted. The Lachenbruch holdout method used in this study to estimate misclassification rates was preferred over the holdout sample method for the following reasons: (1) The holdout sample method requires a fairly large sample size. (2) The estimated misclassification rates relate to the discriminant function based on subsample may differ from the misclassification rates for a function based no the complete sample. (3) Lachenbruch [1967] concluded that Lachenbruch holdout method if normally is questionable and if the sample size is small relative to the number of variables.

To determine whether a significant difference exists in the ability of the five models to discriminate bankrupt from non-bankrupt firms, a **Chi-square** test is used to test whether the difference in the Prediction accuracy between any two models is significant. Elam [1975] and Mensah [1983] use this test in comparing the predictive ability and accuracy of two models constructed from different data. The prediction results of MDS for the five functions described above are presented in Table 3 through Table 7. These tables show the actual group membership, the predicted group membership, the overall percentage of firms correctly predicted, and computed Chi-square.

such as, multiple discriminant analysis (MDA) is applied to derive the prediction results in this study. MDA is a statistical technique designed to classify an observation into one of several prior groupings. It is used primarily to classify and or make predictions in problems where the dependent variable appears in qualitative form (e.g., male or female, bankrupt or non-bankrupt). In the current study, the problem is to predict firms as bankrupt or non-bankrupt. The linear format is appropriate if the variance-covariance matrices are statistically identical. A multivariate normal distribution in each of the populations with equal dispersion matrices is required for the linear format. If, however, the dispersion matrices are not identical, then the quadratic structure would provide the more efficient model. The linear function of the MDA has been chosen over the quadratic function for the following reason: Gilbert [1969] has found that the linear function and the quadratic function produce results that become more alike as the distance between the centroid increases, the difference between the covariance matrices decreases, and as the number of variables in the model decrease. Marks and Dunn [1974] have found that the linear model performs better than the theoretically appropriate quadratic model for small samples. Altman [1977] has found that the level of accuracy achieved by the linear model is usually almost equal to that of the more complex quadratic function. Collins and Green [1982] state that in the bankruptcy context, two important assumptions of MDA are violated. The distribution of financial ratios is usually not normal, and the variability of the financial ratios of bankrupt firms is likely to be much different than that of non-bankrupt firms. MDA models, however, produce good results and are fairly robust to the violations of their assumption created by problems in predicting bankruptcy.

The general form of the linear multiple discriminant function is as follows:

$$Zi = b1X1i + b2X2i + \ldots\ldots\ldots\ldots - + bm \times mi$$

where

Xji = the jth ratio for firm i

bj = the discriminant coefficient for jth ratio

Zi = the discriminant score of firm i

The firms are classified on the basis of their Z-scores as belonging to one of two mutually exclusive groups: bankrupt or non-bankrupt. Five discriminant functions are derived to classify bankrupt and non-bankrupt firms. The first function based on ratios computed with HC information; the second function based on ratios computed with GPL information; the third function based on ratios computed with CC information; the fourth function based on a model that combines ratios computed with both HC and GPL information; and the fifth function based on a model that combines

and non-bankrupt firms were the 10-K financial statements (balance sheet, Income statement, and cash flow statement which are required to be filed to Security and Exchange Commission in USA) and annual reports available on Microfilm.

VARIABLES

In the absence of theory on corporate failure, empirical researchers for example Altman [1968, 1973], Baldwin, Jane; and Glezen, G, William [1992], Burgstahler, David; Jiambalvo, James; and Noreen, Eric, [1989], Chen and Shimerda [1981] Chen, Kevin C W; and Lee, Chi-Wen Jevons [1993], Dambolena and Khoury [1980], Deakin [1972], Dugan et al [1995], Edmister [1972], Elam [1975], Fernandez-Castro, and Smith (1994), Ohlson [1980], Pinches, Eubank, Mingo and Carthorse [1975], Shim, Jae K; and Liew, Chung J. [1993] have chosen variables for inclusion in their models using different perceived theoretical justifications. Based on these studies, fourteen financial ratios are selected on the basis of stability among these studies. For each firm, fourteen financial ratios are computed for each of the three years prior to bankruptcy. **Table 2** lists the financial ratios, which were used in this study to form the basis of the bankruptcy prediction.

Table 2: Financial Ratios used as independent variables in the MDA model

1.	Current assets to current liabilities
2.	Working capital to total assets
3.	Cash flow* to current liabilities
4.	Cash flow* to net worth
5.	Net worth to total assets
6.	Net worth to total liabilities
7.	Sales to working capital
8.	Sales to inventories
9.	Sales to fixed assets
10.	Sales to total assets
11.	Net income to sales
12.	Net income to net worth
13.	Net operating profit to total assets
14.	Net operating profit to total debt

* Cash flow = Net income plus depreciation

4. STATISTICAL ANALYSIS AND RESULTS

The statistical problem in this study is one of classifying or predicting an observation into one of two classes, bankrupt or non-bankrupt, based upon a number of financial ratio variables. A multivariate statistical techniques,

outside economic factors that might create financial difficulties for both bankrupt and non bankrupt firms.

To control of industry-wide and economy-wide effects, the non-failed firms were matched with the failed firms for variable such as industry, size, fiscal year, and the internal accounting methods used for depreciation computations and inventory valuations. The non-failed firms were chosen from the COMPUSTAT annual tapes. Industry is defined as using the three-digit (SIC) code for each firm.

Matching by size was based on the assets of the failed firms within a given industry. The non-bankrupt firm with the asset size most similar to its bankrupt counterpart was chosen. Asset size, rather than net sales, was chosen as the matching criterion since this characteristic tends to be more stable across time. The matched pair "t" test was used to test whether the difference in the assets of the failed and non-failed firms is significantly different from zero. The results in **Table 1** indicate that the differences at **alpha 5%** are not significant for each of the three years before bankruptcy.

Table 1: Difference in the results of the T-test for Asset Size Between bankrupt and non-bankrupt firms

Year	Type	No. of Cases	Mean	SD	Probability
1	B	26	516,966	526,948	0.968
	N	26	522, 483	464,314	
2	B	26	525,490	535,820	0.796
	N	26	490,935	417,194	
3	B	26	466,597	487,705	0.895
	N	26	450,450	387,072	

B - Bankrupt N - Non-bankrupt

Data Collection

Financial statement data were collected for the failed and non-failed firms for three years prior to failure. All of the financial statements for the failed firms used in this study were issued before the firms actually failed. The primary sources of information for financial statements for the bankrupt

3. RESEARCH METHODOLOGY

Sample Selection

Identification of Failed Firms

Data collection for bankrupt firms requires a definition of failure and specifications of the population of firms from which sample firms are to be drawn. For the purpose of this study, business failure is defined as filing a bankruptcy petition under the Federal Bankruptcy Act of USA laws chapter VII and chapter XI. Criteria used for selection of failed firms for this study are as follows:

a) firms that failed during the period 1979 to 1987;

b) firms whose shares were traded on any stock exchange in the USA;

c) firms, which were classified as industrial companies;

d) firms whose financial statements and supplementary information were available for the three year period prior to the failure.

A listing of all known firms which failed between 1979 and 1987 during high inflation in USA (15% average annual rate of inflation) was compiled from the COMPUSTAT Research File and the Wall Street Journal Index. After eliminating firms, which did not meet the above criteria, twenty-six firms were selected in this study. While a larger number of firms would be desirable for analytical purposes, the following observation should be note:

1. The firms included represent the entire population of firms meeting the specified criteria rather than a selected sample of such firms.
2. The relatively short time period for which general price level and current cost disclosures were required guarantees that only a limited number of firms could be expected to meet this criteria.
3. The size of firms which was required to provide supplementary financial statements which showed both the current cost information and the constant-dollar information necessitates that each of the failures would be classified as a major one and as a result the selected sample represents relatively large size firms.

Identification of Non-failed Firms

A set of non-bankrupt companies was selected for a matched pair sample design. A matched pair design is applied for the following reasons: (1) Prior researchers Elam (1975), Ketz [1978] and Mensah [1983], have used matching pair design in previous bankruptcy studies; (2) to control for

test the usefulness of general price level information in classifying or predicting bankruptcy.

The current study intends to investigate the usefulness of supplementary financial disclosures in predicting business failure and alleviating the above problems associated with Aly et al [1992]. Specifically, This study investigates the usefulness of the general price level information (GPL) and the current cost information (CC) as compared to that of historical cost information (HC) in predicting not classifying business failure. The study also examines the usefulness of GPL data versus CC information when each supplements HC information in predicting not classifying business failure.

STATEMENT OF HYPOTHESES

The null hypotheses tested in this study can be stated as follows:

H_{o1} : There are no significant differences in the ability to predict bankrupt from non bankrupt firms between the models using financial ratios computed with GPL data and the models using financial ratios computed with HC data.

H_{o2} : There are no significant differences in the ability to predict bankrupt from non-bankrupt firms between the models using financial ratios computed with CC data and the models using financial ratios computed with HC data.

The predictive power of models using CC or GPL as a supplement to HC may be compared to that of models using HC data only. Solomon and Beck [1980] pointed out that Norton and Smith's [1979] study failed to examine the possible usefulness of GPL data when it is used to supplement HC. Therefore, the third and fourth null hypotheses to be tested can be stated as follows:

H_{o3} : There are no significant differences in the ability to predict bankrupt from non-bankrupt firms between the models using financial ratios computed with combined HC/GPL and the models using financial ratios computed with HC data only

H_{o4} : There are no significant differences in the ability to predict bankrupt from non-bankrupt firms between the models using financial ratios computed with combined HC/CC and the models using financial ratios computed with HC data only

of accounting information, which yields the best prediction of bankruptcy. This type of research is important as an aid to policy-makers who are continually faced with the problem of choosing an appropriate reporting method from among several alternative accounting measures. One of these problem areas is accounting for changing prices. Therefore, the authoritative bodies of the accounting profession in many countries have emphasized the need for empirical studies in the area of changing prices to measure the effect of inflation on the reported earnings and financial positions of firms. The remainder of this paper is arranged as follows: Section two presents the research problem. Section three presents the hypothesis and research method used in this study, including the sample selection criteria, data collection methods, and steps taken to develop the linear discriminant functions. Section four presents the data analysis and results. The conclusions and limitations of the study are presented in sections five and six respectively. Finally, section seven presents the recommendations for future research.

2. STATEMENT OF THE RESEARCH PROBLEM

In the last decade, a large number empirical studies have examined the incremental information in the general price level (GPL) and current cost (CC) over the historical cost information. Most of these studies focused on the stock market reaction to these types of information (for example Hopwood and Schaefer [1989], Lobo and Song [1989], Beaver et al. [1980, 1982, 1983, 1985], Bulitz et al. [1985], Gheyara and Boatsman [1980], Sunder and Waymire [1983], and Watts and Zimmerman [1980].

A few studies have examined the incremental information in the GPL or CC over the HC information in predicting business failure or bond rating changes. Empirical studies using data that have been adjusted for general price level changes include those of Ketz [1978], Monahan and Bareenbaum [1983], and Norton and Smith [1979]. Aly et al [1992] examined the usefulness of the current cost information originally required by SFAS No. 33 versus historical cost information in classifying firms to bankrupt and non-bankrupt. Mensah [1983] used data adjusted for specific price changes.

Aly, et. al., [1992] examined the usefulness of current cost information, as compared to historical cost information, in classifying firms to bankrupt and non-bankrupt firms. Their results indicate that the combined historical cost and current cost model has more classification power than does the historical cost model alone in each of the three years before bankruptcy. However, the study did not test the prediction power of the combined historical cost and current cost model as compared to current cost information or historical coast information. In addition, the study did not

to all data that are of a financial nature and are traditionally contained in corporate reports (annual and quarterly). Most of this information is usually contained in three major documents: the balance sheet, the income statement, and the statement of changes in financial position. This financial information (historical cost information, HC) prepared by employing the nominal-dollar historical cost convention as a measurement unit.

Accountants are primarily responsible for providing financial information about the corporation to investors and creditors so that the performance of corporate management can be evaluated objectively. However, most published accounting information is measured with an unstable unit of measurement in an ever-changing environment of a costs and prices. This fact has led the interested parties such as investors, creditors, and other users to question the use of the nominal-dollars historical cost measurement convention as it ignores the impact of inflation on the reported earnings and financial positions of corporations. In response to this problem, the authoritative bodies of the accounting profession in the United States, Canada and other countries (for example, England, Sweden and Australia) have taken several actions to deal with the impact of changing prices on published financial statements.

In March, 1976, the Securities and Exchange Commission (SEC) called for footnote disclosure of inventories, plant assets, cost of goods sold, and depreciation expense on a replacement cost basis for large publicly held corporations registered with the Commission. The requirements were set forth in ASR 190. In September 1979, the Financial Accounting Standards Board (FASB) issued Statement of Financial Accounting Standards (SFAS) No. 33, Financial Reporting and Changing Prices. This statement required large publicly held corporations to issue supplementary financial statements, which included both constant-dollar (GPL) and current-cost information (CC) along with their primary financial statements (HC). These two types of financial disclosures that relate to changing prices have different objectives and provide different sets of data. The first method (GPL) involves restating historical cost dollars of unequal purchasing power to dollars of uniform purchasing power. The second method (CC) involves restating items in the financial statements to current purchase prices.

Therefore, the purpose of this research is to examine the usefulness of the historical cost (HC) information versus current cost (CC) information and the general price level (GPL) information signals in predicting business failure. Additionally, the study also examines the usefulness of CC information versus GPL when each is used as a supplement to HC information.

The study focuses on predicting bankruptcy through the use of financial ratios. A comparison of these financial ratios is made to identify the type

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The Usefulness of Accounting Information in Predicting Bankruptcy During Inflation Periods: Some Empirical Evidence

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Abstract

This research examines the usefulness of the historical cost (HC) information versus current cost (CC) information and the general price level (GPL) information signals in predicting business failure. The study also examines the usefulness of CC information versus GPL when each is used as a supplement to HC information.

The study focuses on predicting bankruptcy through the use of financial ratios. A comparison of these financial ratios is made to identify the type of accounting information, which yields the best predictions of bankruptcy.

Twenty-six firms, which failed and filed a bankruptcy petition under the Federal Bankruptcy Act of USA laws chapter VII and chapter XI between 1979 and 1987 during high inflation were selected. A set of twenty-six non-bankrupt firms was selected for matched pair sample design.

A multivariate statistical technique, multiple discriminant analysis (MDA) is used to derive the prediction results. Five functions are developed based on ratios computed with HC, GPL, CC, the combined HC/GPL and the combined HC/CC model.

The main results of the various analyses indicate that the combined HC/CC model has more predictive power than does the (HC, the GPL, the CC, or the Combined) models in each of the three years before bankruptcy. Hence, the usefulness of current cost information presented in annual reports can not be denied.

1. INTRODUCTION

One of the major concerns of accounting professionals and policy makers in the latter part of the twentieth century has been the usefulness of published accounting information. Published accounting information refers

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