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Abstract

Bond ratings are widely used by investors in the selection of securities and it is generally recognized that the purpose of these ratings is to rank bonds in terms of their probability of default. This research investigates whether the determinants of bond ratings are relative or absolute by examining a sample of bonds during six periods from 1950 to 1975. The results indicate substantial instability in the size and significance of the determinants over time and that ratings over time are more relative than absolute. These results have important implications for bond portfolio managers and for investigators of bond ratings.

THE CHANGING CRITERIA FOR BOND RATINGS*

Frank K. Reilly**
Paul G. Fellows**

INTRODUCTION

Bond ratings are widely used by investors in the selection of securities and have a profound effect on the required level of return on alternative bonds. Because of their importance, a number of studies have examined the specific variables that influence the assignment of bond ratings [1, 3, 4, 7, 9, 10, 11, 13, 14, 15, 16, 18, 21, 22]. In these investigations it is generally recognized that the purpose of the bond ratings is to rank the bonds in terms of their probability of default. A question that seldom arises is whether the ratings are absolute or relative. Specifically, do the rating agencies have a set of financial criteria for bonds and are those criteria relative consistent over time? If so, this would mean that a bond with a specified set of financial ratios that was rated Baa in 1950, probably would be rated Baa in 1979. Alternatively, one might contend that the ratings are relative and the only important criteria is a bond's <u>relative</u> ranking among all currently outstanding bonds. If so, it would be possible for one to observe a change in the criteria for alternative ratings over time. As an example, one might find that the interest coverage for a sample of Aaa bonds had increased or decreased over time and

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there had likewise been a change in the values of other relevant financial ratios.

The purpose of this paper is to determine whether the financial criteria for the alternative bond ratings have changed over time. To accomplish this we examine a sample of bonds at different points in time and derive a set of financial ratios widely accepted as relevant for each sample. The analysis considers what has happened to the average of these financial ratios for bonds of a given rating over time. As an example, what happened to the "times fixed charge coverage" ratio for Aaa bonds over time (e.g., 1950, 1955, 1960, ...). The sample is selected from newly issued bonds rated by the agencies during specified years.

The first section contains a review of prior studies that have examined what variables influence the risk premium and the ratings for bonds. Based upon this review, a number of variables are selected for analysis. The second section contains a discussion of the sample and the test procedure. In the third section we present and discuss the results. The final section contains a summary and conclusion and discusses the implications of the results for corporations, bond analysts and portfolio managers.

PRIOR STUDIES ON VARIABLES THAT INFLUENCE BOND RATINGS

Fisher Study

The first study to rigorously examine financial variables that one might expect to affect the risk premium of bonds was by Lawrence Fisher [6]. Specifically, he attempted to analyze variables that would influence the risk premium on bonds defined as the difference between the yield on the corporate bond and the yield on a comparable risk-free government bond. It was contended that the risk premium should be a function of the default risk and marketability. In turn, three variables were set forth as influencing the default risk: (1) the variability of earnings as measured by the coefficient of variation of earnings during the prior nine years, (2) a measure of how reliable a firm has been in meeting its financial obligations (how long since it has defaulted on an obligation), and (3) a capital structure variable (market value of stock/book value of debt). The marketability of a firm's bonds was measured by the market value of all publicly traded bonds the firm had outstanding. The coefficients for all the variables had the expected sign and the overall model was quite good in explaining the risk premiums during six periods: 1927, 1929, 1932, 1937, 1949, and 1953. The average coefficients of determination was about .75 and the individual variable coefficients were quite stable.

Horrigan Study

Horrigan [9] was first to attempt to predict bond ratings using financial ratios. A regression of the ratings for a sample of bonds against a number of financial ratios indicated that the best model for predicting bond ratings included the following variables: size of the firm (total assets); working capital/sales; net worth/total debt; sales/net worth (equity turnover); net operating profit/sales (operating profit margin); and a dummy variable that indicated if the issue was subordinated or not. Clearly the two most importnat variables were total assets and subordination. The r^2 was about .65 and using the model he was able to predict about 58 percent of new ratings by Moody's and about 54 percent of rating changes.

West Study

When Richard West commented on the Horrigan study he suggested that it might be preferable to consider multiple year variables similar to what was done by Fisher. Subsequently he carried out a study that employed the variables used by Fisher to predict bond ratings [22]. The results indicated that the Fisher model provided higher r^2 than Horrigan's model with fewer variables and slightly better prediction of ratings. Still, it was acknowledged that the Fisher model required more difficult computations.

Pogue and Soldofsky

Pogue and Soldofsky [15] attempted to predict which of two rating classes a bond would be in on the basis of the following five variables: long-term debt/total capitalization; net income/total assets (a measure of profitability); the coefficient of variation of net income/total assets (variability of profitability); net total assets (size); after tax net income plus interest/interest (interest coverage).

The variable coefficients had the right sign except for profitability and the model was able to correctly rate bonds about 80 percent of the time on a small sample.

Pinches-Mingo Study

Pinches and Mingo [13] initially considered 35 variables as possible explanatory variables and using factor analysis reduced the explanatory set to the following six: subordination; years of consecutive dividends; issue size; net income plus interest/interest (five year year average of interest coverage); long term debt/total assets (five year mean); net income/total assets. Using multiple discriminant analysis, they derived a model that was able to predict the rating correctly 65 percent of the time for a holdout sample and all bonds were classified within one rating class of their assigned rating.

Ross Article

An article by Ross [18] discussed how the various agencies rate bonds and some of the variables considered important by these agencies. The four main variables considered were: net income plus interest/interest (interest coverage); net income plus depreciation/debt (cash flow to senior debt); net tangible assets/long-term debt; and long-term debt/total long-term capital. There is also a brief discussion of the general levels of these ratios appropriate for each rating class.

Ang and Patel

In contrast to developing an alternative model to forecast ratings, Ang and Patel [1] compared the four major models discussed: Horrigan (H), West (W), Pogue and Soldofsky (P-S) and Pinches-Mingo (P-M). There were two comparisons: (1) compare the ability of the various models to duplicate Moody's ratings, and (2) compare all the models and Moody's on their ability to predict financial distress. The samples included 424 bonds issued during 1928, 1932, 1934, 1936, and 1938. In addition to the four models discussed they considered two naive rating models.

The analysis of the statistical rating methods compared to the Moody's ratings indicated a fairly consistent pattern whereby P-S ranked first, P-M second, W third, H fourth and the naive models fifth and sixth. These results substantiate the claim that most statistical ranking techniques duplicate Moody's better than random or naive models. A further analysis also indicated that the four models generally agreed on ratings.

The analysis of the relationship of ratings and ex-post financial distress performance indicated that based on simple rank order, the P-S model was first, Moody's ranks were second, followed by P-M, W, and H. Notably, they found that the degree of accuracy of all models deteriorate as the lead time lengthens. Also, the economic environment became a significant factor explaining financial distress. The authors were mildly surprised that the models using published data did as well as Moody's in predicting financial distress.

Edelman

Rather than attempt to predict ratings by either Moody's or Standard and Poor's, Edelman [4] contended that these ratings were deficient in responding to changes in economic conditions and also did not sufficiently delineate risk differences. Therefore, he proposed an alternative rating system for utility bonds objectively derived using principle components analysis of four operating and financial dimensions: (1) cash flow interest protection and leverage, (2) expected cash flow and capital spending, (3) the operating environment, and (4) the quality of regulation. The model was tested by comparing scores to existing agency ratings and also by examining the method for stability over time. Notably, the variables used in the model were either ratios similar to prior studies or estimates typically provided by Value Line. After demonstrating the scoring, the author examined the rank correlation of the overall factor scores, ratings, and ratio yield spreads. The results indicate that rankings based on factor scores were not substantially different from agency ratings, but the factor scores were more discriminating. There was also evidence of stability over time based upon the relationship between factor scores and ratio yield spreads in 1975 and in 1976. It is noted in the conclusion that there is evidence that the important risk variables change over time. This observation has relevance for the current study dealing with various models over time.

Kaplan-Urwitz

Another study that examined the prior models was by Kaplan and Urwitz [11]. Following an extensive summary and critique of the prior studies the authors pointed out some consistent problems. A major criticism was the use of ordinal rankings in an ordinary least squares (OLS) model. The authors proposed the use of a maximum likelihood model to solve this problem. In addition, they discussed the wide variety of independent variables proposed, including the use of earnings beta and market betas. Also, it was pointed out that several of the studies used seasoned bonds to develop and test their models rather than new issues which are more appropriate. Finally, it was contended that the evaluation of rating predictions by determining the percent of correct predictions was not optimal because it did not consider how strong the expectation was for mis-classified bonds.

They attempted to alleviate these criticisms by using the maximum likelihood model to account for ordinal rankings, by selecting a sample of seasoned bonds and a sample of new issues, and by including a composite of the prior materials used including five year averages and also several beta measures. The variables used were concerned with interest coverage ratios, capitalization (leverage) ratios, profitability ratios, size variables, stability variables and a subordination dummy variable. They also derived industry measures for several variables to allow the use of industry adjusted variables.

The results for the two samples (new and seasoned hands) were generally consistent, although the seasoned regressions had higher R^2. The subordination variable, size variable (total assets), and leverage variable (LTD/TA) were highly significant for both groups. The profitability variable (NI/TA) was more significant for the new issue sample. Notably, the interest and debt coverage ratios were not significant. The market beta was significant, but all other such measures were insignificant. When any beta measures were included, the stability measures were never significant. Finally, there was a significant difference using unadjusted data.

There was an analysis of three selected models on the basis of predictions. The model with the best prediction (69%) included coverage ratios, leverage, profitability, size, subordination, market beta, and unsystematic market risk. The second model that predicted 66 percent correct only included leverage, size, subordination, and market risk. Using the best model they examined whether the mis-classification was due to low probabilities. The expectation was not confirmed—misclassification apparently was not caused by bonds being near a boundary of a category. When ratings were related to market yields, the results were generally as expected, but there was substantial dispersion and overlap. Finally, they tested on specific model (Horrigan's) using OLS and their model that allowed for the ordinal bond rating variable. The results indicated almost no difference in the significance of the coefficients. The authors conclude that there is almost no difference in the two techniques. In fact, the OLS model did slightly better in terms of predicting ratings. Therefore, the use of the OLS model does not bias the equations. Another important conclusion is that the use of seasoned bonds to estimate the model can result in a mis-specified model.

Singleton - Gronewoller - Hennessey (SGH)

The only prior study that considered the question of changing standards for ratings was by Singleton, Gronewoller and Hennessay [20]. They examined 173 firms that issued bonds in 1961, 1966, 1971, and 1976. For each firm they examined three variables (coverage, leverage, and profitability) using multiple analysis of variance to determine: (1) whether bond ratings are relative or absolute, and (2) if the quality of a given rating class changes significantly over time (i.e., is there a regulatory lag?).

The authors state that their results indicate that the standards used in bond ratings are more relative than absolute—apparently Moody's has changed the standards over time, but there is no indication of the direction of changes (i.e., are Aa's more or less risky now compared to 1960?). Also, they found that there were significant differences across rating categories on all three variables, but again there was no indication of the direction of change over time.

They examined the question of regulatory lag by analyzing issues five years after issue to see if their ratings (which had not changed) and quality were consistent with new issues. The results indicated no regulatory lag--apparently new and seasoned bonds were subject to the same quality standards.

While the current study is concerned with the same general question as the SGH study, there are some substantial differences. The current sample is substantially larger (318 vs. 173). Part of this is due to the longer time frame--we considered six years (1950, 1955, 1960, 1965, 1970, 1975) versus four years (1961, 1966, 1971, 1976). Also, all of our data were collected from the Moody's Public Utility Manual, which reflects actual data as reported by the firm in contrast to the SGH study which derived most of its data from Compustat. As pointed out by SGH, Compustat adjusts some financial statement items to match its internal conventions. Finally, as will be shown later, we have examined 12 different variables compared to three by SGH.

Summary of Prior Studies

The results of these prior studies have indicated that it is possible to derive a number of variables that can discriminate between bonds with different ratings and it is possible to develop models that can be used to predict the ratings of forthcoming bonds with substantial accuracy. Notably, all these studies, except SGH, have been cross-sectional. The point of the current study is to determine whether there has been a change in the criteria over time related to different ratings. Because the prior studies discussed did not use the same set of explanatory variables, this study employs a composite group of variables and examines these variables for different rated bonds over time.

STUDY DESIGN AND SAMPLE

This study examines a number of bonds during different time periods over the last 30 years using a common set of financial variables and attempts to determine if the quality of bonds assigned to different rating classes has changed over time. Put another way, the results should indicate whether the determinants of bond ratings are absolute or relative.

Rating Variables

The discussion in section one indicated the variables considered in each of the studies. The idea is to select those variables that were used in several of the studies, those that appear logically defensible and also appear to provide useful predictions. Given the several variables, a number were duplicated in multiple studies (e.g., interest coverage; equity-debt ratio; debt-total capital ratio). Two variables would not be very discriminating in a time series study—number of years since default and number of years of consecutive dividends. Therefore, the final selection includes the 13 variables listed in Table 1. These variables indicate the quality of the sample bond issues over time. In addition to the 13 quantitative variables there is one qualitative measure—subordination. This latter variable will probably not be useful over time since the proportion of subordinated bonds will probably not change or certain ratings will probably not change in terms of subordination.

TABLE 1

A COMMON SET OF ACCOUNTING AND FINANCIAL VARIABLES USED TO RATE BONDS

1. Size of firm (total assets)
2. Issue size
3. Market value of all publicly traded bonds of firm
4. Working capital/sales
5. Sales/net worth
6. Net operating profit/sales
7. Net income/total assets (return on assets) - last 5 years
8. C.V.* of net earnings (5 years)
9. C.V.* of return on assets
10. Net income plus interest/interest expense
11. Market value of stock/par value of bonds
12. Long-term debt/total assets - last 5 years
13. Net income plus depreciation/long-term senior debt
14. Subordination

*C.V. - coefficient of variation which is equal to the standard deviation divided by the mean.

Time Period

The intent is to examine a number of separate historical time periods to allow for significant changes, while avoiding time periods that would no longer be applicable. Therefore, we examined a sample of bonds during each of the years: 1950, 1955, 1960, 1965, 1970, 1975. This selection avoids the abnormal war period of the 1940's, the depression years of the 1930's, and provides six sample groups that should allow for the development of a trend in the alternative financial ratios.

The bonds used in the empirical study were all new issues of electric utilities. Electric utilities were selected to ensure comparable accounting procedures across all firms in the sample. The study was limited to new issues as suggested by Kaplan and Urwitz [11] so that the peculiarities of rating changes prior to the issue date were irrelevant. The sample was selected as follows. First, for each of the years 1950, 1955, 1960, 1965, 1970 and 1975 Moody's Bond Record was searched for new issues of nonconvertible utility company bonds with a minimum term to maturity of 20 years rated AAA, AA, A or BAA. In no case was a second new issue used for any particular firm in a rating year. However, some new issues of the same firm were included in different rating years—for instance, a new AA rated bond of Dallas Power and Light was used in the 1950 sample and another AA rated bond of Dallas Power and Light was used in the 1955 sample. We used the Moody's Public Utility Manuals for the years 1950, 1955, 1960, 1965 and 1970 and 1975 to collect accounting data for the five years prior to the rating. For example, accounting data for the years 1945, 1946, 1947, 1948 and 1949 was used for the analysis of the 1950 new issue of Dallas Power and Light. We required five years of accounting data available in the Manual. The distribution of ratings by years is shown in Table 2. Overall, 318 different bonds are used in the study.

Raw Data

The data collected for each of these 318 bonds consists of information about the bond, the firm, and general market information. In particular, the following bond and market information was gathered:

(1) Rating class as determined by Moody's. In addition, Standard and Poor's Bond Guides were used to check the S&P rating. There were 24 cases when the S&P rating was higher and 16 cases when the S&P rating was lower and 2 cases when the issue was not rated by S&P.

(2) The yield to maturity at the time of issue as reported by Moody's.

(3) The size of the new issue as reported by Moody's.

The following accounting information was gathered for each of the five years prior to issue:

(4) Net working capital.

(5) Total assets.

(6) Total long term debt.

(7) Total stockholders equity (preferred and common at book value).

(8) Total revenues.

(9) Depreciation charges.

(10) Earnings before interest and taxes.

(11) Interest expense.

(12) Net income.

TABLE 2

DISTRIBUTION OF RATINGS BY YEARS

Year	AAA	AA	A	BAA	Total
1950	4	15	22	4	45
1955	5	18	15	1	39
1960	8	26	15	2	51
1965	3	16	13	4	36
1970	10	43	28	5	86
1975	5	28	23	5	61
Total	35	146	116	21	318

Variable Definitions

The fourteen variables used in the analysis are defined as follows:

X_1 Moody's bond rating on a nine point scale, i.e., bonds rated AAA were coded as 9, AA as 8, etc.

X_2 Total assets defined as the average of the prior five year's values.

X_3 Long term debt defined as the average of the prior five year's values.

X_4 Working capital to sales ratio defined as the average of the prior five years ratios of net working capital to revenues.

X_5 Sales to equity ratio defined as the average of the prior five year's ratios of revenues to stockholders equity.

X_6 "Operating" profit margin. Five year average of earnings before interest and tax/revenues.

X_7 Return on total assets. Five year average of net income/total assets.

X_8 Coefficient of variation of net income. The standard deviation of net income divided by the average net income over the five year period.

X_9 Coefficient of variation of return on total assets. The standard deviation of X_7 divided by X_7.

X_{10} Interest coverage. The five year average of net income plus interest/interest.

X_{11} Long term debt ratio. The five year average of long term debt/total assets.

X_{12} "Cash flow" ratio defined as the average of the prior five year's ratios of net income plus depreciation to long term debt.

X_{13} Yield to maturity.

X_{14} Issue size.

The use of five year averages reflect the belief that bond raters use more than just the most recent data [see 11].

PRESENTATION OF RESULTS

The purpose of this study is to examine the variables that determine bond ratings and determine if the significant variables have changed over time. In order to arrive at a conclusion in this regard, the results will be presented in four parts. Initially we will examine the values for the different variables by rating in an indication of the significant variables. The second phase involves an analysis of the levels of the variables over time by ratings--e.g., the coverage ratio over time for AAA bonds. This should be a prime indication of changes over time in rating criteria. In the third segment we will examine the correlations over time between each of the variables and the ratings. Again, this should provide evidence of changes in the relationships over time--e.g., is the correlation between bond ratings and return on assets the same, better, or worse in 1975 compared to 1955? The final phase involves the analysis of several multiple regression models during the alternative periods to see if the results change over time for the overall model and also for individual variables in the model. The regression models considered will be linear, linear stepwise, and non-linear.

Variable Values by Rating

Table 3 contains the mean and standard deviations for all the variables by rating class. As noted, an analysis of these values should indicate which variables should be most significant in explaining rating differences—i.e, we are looking for significant differences in a consistent pattern.

The results for total assets and long-term debt are not consistently different and the standard deviations are large. There are some differences in average issue size, but again the standard deviations are large. These results are impacted by the fact that the means for values over time are influenced by the secular trend in these size variables. We did a chi-square test on all the remaining variables to determine if the means and standard deviation were from the same population. The results indicated that with the exception of the equity turnover variable (S/E) and operating earnings margin (EBIT/S), all the variable values for different ratings came from different populations—e.g., there is a significant difference in the return on assets for the companies in different rating groups. This would imply that several of these variables should be significant in explaining differences in ratings.

Variables Over Time

Tables 4-7 contain the means and standard deviations for each of the variables during each of the six years. The purpose of the analysis is to determine for each rating class if there been a significant change in the values for a particular variable over time? This analysis is obviously at the center of the study since it should indicate if there has been a change in criteria over time--e.g., has there been a significant change in the interest coverage ratio for AAA bonds during the period 1950 to 1975?

To test for changes we used a t-test of difference in means and limit our analysis to comparing the first year (1950) to the last year (1975). Obviously it is possible to examine a number of other periods, but the calculations would increase geometrically and it would be very difficult to generalize.

An analysis of the ratios in Table 4 indicated significant changes in the WC/S ratio and the NI + I/I ratio at the .01 level and the EBIT/S ratio at the .10 level. The ratios for AA rated bonds in Table 5 indicated significant changes (at the .01 level) in: WC/S; S/E; CV(R+n); and NI + I/I. For the A rated bonds in Table 6 there were significant changes (.01 level) in: WC/S; EBIT/S; CV(R+n); and NI + I/I. Also at the .05 level for NI/TA. Finally, the BAA rated bonds in Table 7 experienced significant changes (at .01 level) in WC/S and at the .10 level in CV(NI) and NI + I/I.

In summary, the bonds in all rating classes experienced a significant decline in the WC/S ratio from 1950 to 1975. Notably, the ratio not only declined, but actually turned <u>negative</u> in all cases. Also, for all ratings, the interest coverage ratio (NI + I/I) also declined significantly (at .10 level for BAA). The other significant changes were scattered among the various ratios and the direction of change was not always consistent.

The two significant changes that were also consistent in direction indicated a <u>decline</u> in quality--i.e., a significant reduction in working capital and a decline in interest coverage. It is also noteworthy that while the coverage ratio declined, the other leverage ratios did not experience significant changes. While any changes that did occur were in the same direction, none were significant. This probably reflects the nature of balance sheet ratios to be less responsive to inflation and higher interest rates compared to the coverage ratio. One would expect a more dramatic change in the coverage ratios since 1975 due to much higher rates.

Correlations Over Time

Table 8 contains the correlations over time for all the independent variables with bond ratings. The purpose is to determine what changes have occurred in these correlations. We not only want to see what has happened to the average value for certain variables, but also determine if there are any changes in the impact of alternative variables. As an example, size measured in terms of total assets has typically been put forth as an important variable in explaining bond ratings. The question is, has this relationship between bond ratings and size changed? We employed the Fisher Z statistic to test for significant changes in the correlation coefficients in 1975 compared to 1950. This analysis indicated significant (at the .05 level or better) declines in the correlations with TA; LTD; CV(NI); and CV(R+n) and significant increases in the correlations with S/E and EBIT/S. Both of these latter correlations changed from negative to positive as one would hypothesize. The correlation with issue size declined, but it was only significant at the .17 level; NI/TA increased at the .10 level, while NI+D/LTD increased at the .11 level. All other changes were clearly insignificant.

The important point is, there were several significant changes in the relationships over time. Specifically, the size variables (except issue size) declined in explanatory power, while profitability and coverage ratios tended to increase in importance.

Multiple Regression Models

In this subsection we examine the performance of a number of multiple regression models used to explain bond ratings at a point in time. The objective is to determine whether the models and/or the individual variable results change over time. Table 9 contains the results for two models each with three popular variables.

The regressions in Part A of Table 9 include TA, NI/TA, and LTD/TA. There are a number of significant changes including the coefficients, the significance of the coefficients based on the t-values, as well as the R^2 and the F values. The coefficients for the TA variable declined in size and became insignificant in 1975. The return on asset ratio was significant, became insignificant in 1955 and 1960 and returned to significant during recent periods. The leverage variable (LTD/TA) was also significant initially but not during the last two periods. The overall results improved and reached a high point in 1965 followed by declines to a low of .25 in 1975.

The regressions in Part B of Table 9 include TA, CV(NI), and NI+I/I. Again, there are significant changes in the coefficients, t-values, R^2 and F values. Again, the TA coefficients were significant in 1955, 1960, 1965 and 1970 but not in 1975. The coefficients for CV(NI) were generally insignificant and even changed sign. The best coefficients were with the coverage variable that was significant except in 1950. The R^2 and F values were very similar to those in part A.

To specifically test whether the coefficients for alternative variables changed over time, we employed a test suggested by Lawrence Fisher [6]. It is a test of the significance of the differences of the partial regression coefficients (b_i's) among the cross sections. Let s_{it} be the standard error of estimate of b_{it} and let

$$b_i^* = \frac{\sum_{t=1}^{T} b_{it}/s_{it}^2}{\sum_{t=1}^{T} 1/s_{it}^2}$$

Then the statistic

$$y = \sum_{t=1}^{T} \frac{(b_{it}-b_i^*)^2}{s_{it}^2}$$

has approximately the χ^2 distribution with T-1 degrees of freedom. Hence an improbably high value of y is cause for rejecting the hypothesis that the partial regression coefficients are estimates from the same population.

When the test was applied to the partial regression coefficients in Table 9 for t = 1950, 1955, 1960, 1965, 1970, and 1975, the following results were obtained.

Coefficient	b*	χ	Prob. of obtaining as large as χ^2	Accept. Hyp. that Coeff. are Equal
TA	.0270	21.858	< .01	No
NI/TA	39.628	16.284	< .01	No
LTD/TA	-4.317	14.704	< .02	No
			B.	
TA	.2842	17.3960	< .01	No
CV(NI)	-1.554	9.3596	< .10	Probably No
BI+I/I	.6888	72.8371	< .01	No

In five of the six cases one would clearly not accept the hypothesis that the coefficients are equal. In the other case it would be marginal, but given that this is the instance where the signs changed, we would tend toward rejection on a priori grounds.

Table 10 contains additional multiple regressions with four variables--the first three are the same (TA, NI/TA, CV(N.I.)) and the fourth one is either LTD/TA (Part A) or NI+I/I (Part B). While the overall R^2's are at least as good or better than those in Table 9, the coefficients and t-values are likewise very unstable. Although all the signs are as expected, there is no instance when the coefficients for a given variable are consistently insignificant. The Fisher test for equality of coefficients generated the following results.

Coefficient	b*	χ	Prob. of obtaining as large as χ^2	Accept Hyp. that coeff. are equal
			A.	
TA	.431 E-6	7.23	< .15	Yes
NI/TA	35.71	19.65	< .01	No
CV(NI)	-1.70	5.89	< .20	Yes
LTD/TA	-3.70	17.75	< .01	No
			B.	
TA	.265 E-6	14.42	< .02	No
NI/TA	-0.77	34.18	< .01	No
CV(NI)	-1.38	9.33	< .10	Yes
NI+I/I	.38	50.19	< .01	NO

Again, in the majority of the cases, one should not accept the hypothesis that the coefficients over time are the same. This confirms that the impact of alternative variables on bond ratings changes over time.

Stepwise Regressions

In contrast to the regressions in Tables 9 and 10 where we selected the variables for the regression based upon prior studies, the stepwise regressions in Table 11 include all the available variables and allow the program to select those that have the greatest explanatory power. The addition of variables stops when there is an adverse tradeoff between the R^2 and the F-value. As a result, the number of variables included in any model can and will differ--in our analysis it is either two or three variables.

The most striking characteristic of the results is the changes in the variables that enter the model. On balance, the variables in the 1950 model seldom enter another model. Notably, the issue variable enters the model in all years after 1950. Otherwise, there is always a financial risk variable in the model, but it varies over time. It is the leverage variable (LTD/TA) in 1955 and 1960, the coverage variable (NI+I/I) in 1956 and 1970 and the cash flow variable (NI+D/LTD) in 1975. The other two variables appear almost random. With two exceptions in 1950, all the coefficients are significant.

A positive attribute of this stepwise technique is that the overall explanatory power of the model is quite consistent--i.e, it varies from .38 to .56. In terms of the basic question of the study, these results are consistent with the notion that the variables which explain bond ratings have definitely changed over time.

Nonlinear Regressions

Our final analysis involves the examination of a set of nonlinear models to explain bond ratings over time. Such models are consistent with the study by Fisher [6] and the subsequent work by West [22]. For this analysis, we pre-select three variables that are similar to those used by Fisher and West for all the years (we do not have a variable similar to years since default).

The results in Table 12 for individual variables changed substantially over time in terms of the value of the coefficients and the t-values (significance). The CV(NI) variable changed size, sign, and generally was not significant. The LTD/TA was always negative, was almost always significant, but changed size over time. Finally, the LTD variable was quite good during the first five periods in terms of size and significance, but changed sign and became insignificant in 1975. Also, the overall results in terms of R^2 and F value were very good during the first four periods, but declined dramatically during the two recent years.

In summary, these results confirm earlier results that indicate instability for alternative variables over time.

SUMMARY AND CONCLUSION

Summary

Bond ratings are a significant aspect of our capital markets as widely accepted indications of the probability of default. Because of their importance, a number of studies have employed alternative models to analyze what variables are useful in explaining and predicting bond ratings. Notably, with one exception, all of these studies were cross-sectional and typically looked at the ratings assigned during an individual year or during some short time period. A neglected question concerns what has happened to the rating criteria over time. This study examined this latter question by examining a sample of 358 bonds during six years from 1950 to 1975. Based upon the results of prior studies, 12 variables were considered.

An analysis of individual variables over time for bonds with different ratings indicated a number of significant changes. The major changes were in the working capital to sales ratio and the interest coverage ratio. Notably, the change in ratios indicated a decline in quality. An analysis of individual correlations between bond ratings and the alternative variables over time likewise indicated some significant changes in the correlations. It appeared that the size variables declined in importance, while the profitability and coverage variables increased in significance. Several multiple regression models were examined that included pre-specified independent variables. The results indicated substantial instability in the size and significance of the coefficients over time. Specific tests of equality of the coefficients almost always indicated that one should reject the hypothesis of equality. Subsequent analysis using a stepwise procedure which allows the program to select variables confirmed those results since the models generally differed over time in terms of the variables that entered with the exception that issue size entered during five of the six years. Finally, we tested a nonlinear model similar to the Fisher-West specification. Again, the results indicated instability in the variable coefficients and significance over time.

Conclusion

The results indicate that the criteria for alternative bond ratings have experienced some significant changes in terms of several of the key financial ratios. This would indicate that the ratings over time are more relative than absolute—i.e., the absolute quality of an AAA bond in 1975 is not the same quality as an AAA bond in 1950. We are convinced that if this analysis were to be extended to 1980, the changes would be confirmed.

In addition, the results provide strong evidence that the determinants of bond ratings have changed substantially over time—i.e., the important variables that explain and help predict ratings are not stable. While there may always be concern with financial risk, the variable that best reflects that financial risk changes over time—e.g., for one period it is a leverage measure, for another it is a coverage variable.

Implications

The fact that bond ratings are relative over time means that the underlying quality of a portfolio can change over time even if the ratings do not—e.g., a portfolio manager may continue to invest in AA bonds, but the underlying quality of the portfolio in terms of probability of default could have changed. As long as the portfolio manager recognizes this and is willing to maintain a relative quality position there is no problem.

The results which indicate that the determinants of bond ratings change has some serious implications for investigators of bond ratings. This instability means that irrespective of the statistical technique employed, the variables may change, which means that a model that worked in 1970 or 1975 may not be the best model for 1980. Not only is it necessary to adjust the coefficients for the variables, but it is very possible that one should change the variables included in the model.

TABLE 3

MEANS AND STANDARD DEVIATIONS OF ALL VARIABLES
BY RATING CLASS ACROSS ALL YEARS

Rating	TA (000)	LTD (000)	Issue (millions)	WC/S	S/E	EBIT/S
AAA	575609 (722493)	248097 (325357)	36 (24)	.017 (.114)	.639 (.107)	.425 (.064)
AA	551572 (627136)	253786 (296619)	37 (27)	-.024 (.130)	.662 (.169)	.406 (.073)
A	401286 (609255)	195386 (299931)	24 (23)	-.007 (.131)	.649 (.152)	.410 (.070)
BAA	580450 (857656)	276215 (387440)	26 (27)	-.113 (.181)	.632 (.130)	.392 (.068)

	NI/TA	CV(NI)	CV(R+n)	$\frac{NI+I}{I}$	$\frac{LTD}{TA}$	$\frac{NI+D}{LTD}$	YTM (%)
AAA	.048 (.009)	.126 (.048)	.069 (.037)	4.37 (.74)	.419 (.037)	.186 (.029)	6.06 (2.59)
AA	.044 (.009)	.136 (.063)	.087 (.060)	3.88 (1.16)	.440 (.055)	.167 (.052)	6.42 (2.66)
A	.041 (.006)	.178 (.004)	.097 (.070)	3.35 (.67)	.479 (.042)	.140 (.027)	6.40 (3.06)
BAA	.035 (.006)	.214 (.116)	.101 (.065)	2.80 (.61)	.484 (.089)	.127 (.057)	7.17 (3.47)

TABLE 4

MEAN AND STANDARD DEVIATIONS OF ALL VARIABLES
OVER TIME - AAA BONDS

Year (No.)	TA (000)	LTD (000)	Issue (millions)	WC/S	S/E	EBIT/S
1950 (4)	155,580 (44,266)	60,631 (14,779)	17.5 (5.6)	.199 (.127)	.574 (.064)	.374 (.044)
1955 (5)	306,817 (170,136)	126,750 (74,418)	31.2 (14.0)	.094 (.120)	.597 (.099)	.371 (.327)
1960 (8)	352,175 (206,655)	228,602 (206,410)	28.9 (10.4)	.023 (.051)	.636 (.116)	.399 (.040)
1965 (3)	326,432 (61,302)	127,957 (20,653)	18.0 (6.1)	-.011 (.075)	.590 (.064)	.495 (.078)
1970 (10)	604,235 (357,654)	255,484 (151,293)	40.0 (17.3)	-.060 (.065)	.698 (.113)	.464 (.062)
1975 (5)	1,367,980 (1,640,980)	607,989 (735,267)	70.0 (41.1)	-.042 (.083)	.648 (.111)	.439 (.054)

Year (No.)	NI/TA	CV(NI)	CV(R+n)	$\frac{NI+I}{I}$	$\frac{LTD}{TA}$	$\frac{NI+D}{LTD}$	YTM (%)
1950 (4)	.045 (.009)	.125 (.061)	.076 (.029)	5.00 (.60)	.398 (.066)	.192 (.026)	2.66 (.043)
1955 (5)	.039 (.004)	.151 (.071)	.095 (.035)	4.50 (.53)	.408 (.038)	.164 (.020)	3.14 (.125)
1960 (8)	.043 (.004)	.133 (.044)	.064 (.019)	4.38 (.44)	.424 (.032)	.168 (.021)	4.81 (.145)
1965 (3)	.050 (.012)	.138 (.042)	.068 (.021)	4.71 (.56)	.394 (.026)	.202 (.010)	4.56 (.168)
1970 (10)	.055 (.008)	.100 (.036)	.053 (.038)	4.52 (.73)	.422 .031	.208 (.033)	8.77 (.240)
1975 (5)	.050 (.009)	.133 (.045)	.076 (.062)	3.23 (.45)	.445 (.024)	.181 (.016)	9.10 (.321)

TABLE 5

MEANS AND STANDARD DEVIATIONS OF ALL VARIABLES
OVER TIME - AA BONDS

Year (No.)	TA	LTD	Issue	WC/S	S/E	EBIT/S
1950 (15)	231,241 (271,343)	104,087 (123,012)	24.0 (19.8)	.175 (.107)	.598 (.110)	.364 (.065)
1955 (18)	385,097 (485,088)	170,834 (200,208)	24.4 (18.6)	.041 (.103)	.613 (.124)	.381 (.091)
1960 (26)	474,265 (513,479)	220,869 (245,620)	29.3 (18.0)	-.031 (.146)	.595 (.110)	.431 (.061)
1965 (16)	843,072 (869,892)	403,305 (432,023)	37.9 (25.9)	-.014 (.046)	.632 (.090)	.449 (.066)
1970 (43)	550,075 (594,550)	253,104 (284,554)	37.9 (24.3)	-.075 (.082)	.708 (.156)	.410 (.060)
1975 (28)	738,892 (734,484)	333,366 (340,554)	56.6 (33.6)	-.093 (.113)	.759 (.223)	.389 (.078)

Year (No.)	NI/TA	CV(NI)	CV(R+n)	NI+I / I	LTD / TA	NI+D / LTD	YTM (%)
1950 (15)	.045 (.010)	.142 (.058)	.158 (.076)	5.21 (2.25)	.413 (.106)	.199 (.117)	2.71 (.044)
1955 (18)	.039 (.0085)	.186 (.051)	.095 (.056)	4.18 (.77)	.433 (.062)	.146 (.033)	3.23 (.075)
1960 (26)	.042 (.0064)	.132 (.046)	.071 (.037)	4.12 (.71)	.449 (.040)	.152 (.028)	4.80 (.175)
1965 (16)	.046 (.0085)	.138 (.056)	.063 (.069)	3.91 (.71)	.454 (.043)	.157 (.034)	4.61 (.156)
1970 (43)	.047 (.0060)	.095 (.042)	.071 (.047)	3.84 (.62)	.444 (.037)	.177 (.029)	8.76 (.408)
1975 (28)	.044 (.0099)	.167 (.077)	.098 (.058)	2.92 (.65)	.436 (.054)	.173 (.044)	9.49 (.504)

TABLE 6

MEANS AND STANDARD DEVIATIONS OF ALL VARIABLES
OVER TIME - A BONDS

Year (No.)	TA	LTD	Issue	WC/S	S/E	EBIT/S
1950 (22)	92,603 (94,929)	43,472 (39,483)	12.3 (13.6)	.121 (.108)	.659 (.118)	.404 (.048)
1955 (15)	183,255 (154,963)	91,644 (78,096)	13.3 (7.6)	.079 (.124)	.606 (.130)	.419 (.057)
1960 (15)	183,867 (122,450)	91,713 (62,628)	10.8 (5.9)	-.007 (.067)	.563 (.120)	.464 (.043)
1965 (13)	225,239 (218,173)	107,697 (104,835)	20.3 (11.3)	-.057 (.096)	.668 (.181)	.438 (.138)
1970 (28)	572,516 (818,726)	282,589 (407,676)	33.3 (30.7)	-.038 (.091)	.684 (.180)	.409 (.049)
1975 (23)	871,587 (781,973)	419,369 (304,695)	41.5 (23.4)	-.136 (.132)	.670 (.144)	.365 (.047)

Year (No.)	NI/TA	CV(NI)	CV(R+n)	NI+I / I	LTD / TA	NI+D / LTD	YTM (%)
1950 (22)	.043 (.0074)	.240 (.068)	.176 (.072)	3.99 (.66)	.480 (.034)	.141 (.028)	2.79 (.064)
1955 (15)	.037 (.0054)	.190 (.081)	.080 (.048)	3.43 (.46)	.493 (.039)	.121 (.021)	3.34 (.091)
1960 (15)	.040 (.0073)	.146 (.047)	.081 (.085)	3.53 (.60)	.493 (.040)	.125 (.029)	5.03 (.158)
1965 (13)	.042 (.0051)	.134 (.065)	.060 (.030)	3.55 (.50)	.465 (.040)	.154 (.024)	4.69 (.146)
1970 (28)	.042 (.0044)	.133 (.068)	.067 (.049)	3.21 (.42)	.474 (.046)	.151 (.027)	9.15 (.461)
1975 (23)	.039 (.0052)	.213 (.097)	.101 (.050)	2.60 (.32)	.475 (.045)	.139 (.020)	10.35 (.498)

TABLE 7

MEANS AND STANDARD DEVIATIONS OF ALL VARIABLES OVER TIME - BAA BONDS

Year (No.)	TA	LTD	Issue	WC/S	S/E	EBIT/S
1950 (4)	51,926 (36,040)	26,489 (18,972)	10.2 (8.3)	.086 (.093)	.565 (.121)	.386 (.556)
1955 (1)	114,524	68,625	10.0	.072	.625	.467
1960 (2)	151,779 (174,717)	85,456 (104,076)	12.5 (10.6)	-.187 (.342)	.699 (.239)	.390 (.078)
1965 (4)	242,895 (234,862)	124,863 (122,463)	13.5 (11.2)	-.073 (.091)	.618 (.123)	.416 (.058)
1970 (5)	319,394 (278,422)	171,655 (151,626)	19.5 (8.7)	-.218 (.177)	.637 (.165)	.408 (.078)
1975 (5)	1,799,020 (1,034,220)	819,461 (465,329)	70.0 (20.9)	-.203 (.122)	.665 (.117)	.350 (.081)

Year (No.)	NI/TA	CV(NI)	CV(R+n)	NI+I / I	LTD / TA	NI+D / LTD	YTM (%)
1950 (4)	.032 (.011)	.346 (.132)	.205 (.469)	3.24 (1.08)	.4641 (.102)	.128 (.071)	2.88 (.021)
1955 (1)	.040	.298	.087	3.32	.597	.097	3.55
1960 (2)	.040 (.0064)	.224 (.064)	.110 (.011)	2.94 (.42)	.498 (.112)	.126 (.026)	5.06 (.035)
1965 (4)	.038 (.0044)	.192 (.081)	.074 (.058)	3.09 (.37)	.508 (.015)	.117 (.013)	4.94 (.029)
1970 (5)	.034 (.0024)	.102 (.053)	.043 (.012)	2.50 (.21)	.470 (.151)	.144 (.104)	9.65 (.236)
1975 (5)	.032 (.0045)	.219 (.100)	.0961 (.030)	2.33 (.15)	.465 (.029)	.124 (.019)	11.50 (.469)

TABLE 8

CORRELATIONS OF INDEPENDENT VARIABLES
WITH BOND RATINGS BY YEAR

Year (No.)	TA	LTD	Issue	WC/S	S/E	EBIT/S
1950 (45)	.29	.26	.27	.31	-.13	-.22
1955 (39)	.22	.17	.43	-.03	-.01	-.29
1960 (51)	.22	.27	.45	.17	.09	-.25
1965 (36)	.28	.25	.29	.30	-.09	.17
1970 (36)	.05	.01	.16	.11	.09	.20
1975 (61)	-.13	-.15	.13	.31	.12	.31

Year (No.)	NI/TA	CV(NI)	CV(R+n)	NI+I / I	LTD / TA	NI+D / LTD	YTM
1950 (45)	.31	-.66	-.38	.40	-.38	.33	-.74
1955 (39)	.11	-.24	.12	.53	-.60	.54	-.68
1960 (51)	.17	-.26	-.16	.50	-.52	.49	-.48
1965 (36)	.40	-.17	-.02	.55	-.52	.50	-.55
1970 (36)	.66	-.20	.03	.67	-.31	.46	-.48
1975 (61)	.43	-.30	-.08	.43	-.28	.49	-.79

TABLE 9

MULTIPLE REGRESSION MODELS FOR RATINGS
(THREE INDEPENDENT VARIABLES)

Rating =	γ_0 +	$\gamma_1 TA$ +	$\gamma_2 \frac{NI}{TA}$ +	$\gamma_3 \frac{LTD}{TA}$	R^2	F
1950	7.25	.00000172 (3.01)	30.49 (2.70)	-3.06 (-2.41)	.34	7.1
1955	10.23	.000000476 (1.62)	9.27 (.62)	-6.63 (-4.39)	.41	8.0
1960	10.87	.00000567 (2.42)	11.13 (.71)	-8.15 (-4.12)	.35	8.4
1965	9.29	.000000688 (4.43)	41.35 (2.85)	-8.64 (-3.67)	.57	14.1
1970	5.56	.000000232 (2.35)	64.26 (7.44)	-2.06 (-1.66)	.47	24.6
1975	7.07	.0000000229 (.23)	38.03 (3.61)	-2.52 (-1.37)	.25	6.5

B.

Rating =	γ_0 +	$\gamma_1 TA$ +	$\gamma_2 CV(NI)$ +	$\gamma_3 \frac{NI+I}{I}$	R^2	F
1950	7.83	.000000510 (.83)	-4.40 (-3.44)	.097 (1.32)	.46	11.8
1955	5.50	.000000706 (2.46)	-1.36 (-.95)	.569 (4.19)	.40	7.9
1960	5.20	.000000640 (2.66)	.020 (.01)	.596 (4.40)	.36	8.8
1965	4.01	.000000684 (4.42)	-.489 (-.29)	.857 (5.57)	.57	14.0
1970	4.83	.000000235 (2.30)	.568 (.47)	.730 (8.41)	.48	25.7
1975	6.36	.0000000308 (.30)	-2.14 (-2.09)	.560 (2.78)	.24	6.0

TABLE 10

MULTIPLE REGRESSION MODELS FOR BOND RATINGS
(FOUR INDEPENDENT VARIABLES)

Ratings =	α_0 +	$\alpha_1 TA$ +	$\alpha_2 \frac{NI}{TA}$ +	$\alpha_3 CU(NI)$ +	$\alpha_4 \frac{LTD}{TA}$	R^2	F
1950	8.03	.000000587	14.76	-4.20	-1.02	.47	8.9
		(.92)	(1.29)	(-3.10)	(-.77)		
1955	10.43	.000000468	7.74	-1.37	-6.39	.42	6.2
		(1.59)	(.52)	(-.95)	(-4.16)		
1960	10.97	.00000053	9.88	-.86	-7.96	.35	6.3
		(2.12)	(.61)	(-.43)	(-3.91)		
1965	9.38	.000000699	40.00	-.76	-8.48	.57	10.4
		(4.40)	(2.67)	(-.45)	(-3.52)		
1970	5.57	.000000230	64.10	-.099	-2.05	.47	18.2
		(2.22)	(7.19)	(-.08)	(-1.63)		
1975	7.42	.000000049	36.45	-2.14	-2.33	.31	6.4
		(.49)	(3.57)	(-2.17)	(-1.31)		

B.

Ratings =	α_0 +	$\alpha_1 TA$ +	$\alpha_2 \frac{NI}{TA}$ +	$\alpha_3 CU(NI)$ +	$\alpha_4 \frac{NI+I}{I}$	R^2	F
1950	7.45	.000000650	9.80	-4.17	.073	.47	9.0
		(1.01)	(.80)	(-3.17)	(.91)		
1955	6.27	.000000531	-63.44	-1.26	1.00	.55	10.2
		(2.04)	(-3.26)	(-.99)	(5.60)		
1960	6.32	.000000444	-95.75	.99	1.31	.52	12.5
		(2.06)	(-3.95)	(.55)	(6.08)		
1965	3.91	.000000694	6.86	-.47	.80	.57	10.2
		(4.35)	(.33)	(-.27)	(3.47)		
1970	4.47	.000000231	28.94	.44	.47	.50	20.6
		(2.35)	(1.78)	(.37)	(2.80)		
1975	6.15	.00000040	33.74	-2.16	.12	.29	5.8
		(.40)	(2.05)	(-2.17)	(.45)		

TABLE 11

STEPWISE REGRESSIONS OF RANKINGS
AND INDEPENDENT VARIABLES FOR ALTERNATIVE YEARS

<u>Year</u>					R^2	F
1950	7.88	− 4.70 CV(NI) (−4.55)	+ 1.43 $\frac{WC}{S}$ (1.77)	+ .069 $\frac{NI+I}{I}$ (1.11)	.46	13.3
1955	10.24	− 6.33 $\frac{LTD}{TA}$ (−4.58)	+ .017 Issue + (2.90)		.45	16.8
1960	11.12	− 8.32 $\frac{LTD}{TA}$ (−5.02)	+ .021 Issue (4.34)		.45	21.7
1965	3.54	+ .89 $\frac{NI+I}{I}$ (6.34)	+ .022 Issue (4.78)		.56	23.4
1970	4.52	+ .40 $\frac{NI+I}{I}$ (2.47)	+ .006 Issue (2.59)	+ 32.79 $\frac{NI}{TA}$ (2.03)	.49	28.4
1975	5.82	+ 11.01 $\frac{NI+D}{LTD}$ (5.31)	+ 2.27 $\frac{WC}{S}$ (3.55)	+ .005 Issue (1.87)	.33	13.0

TABLE 12

REGRESSION RESULTS FOR NON-LINEAR MODEL
DURING ALTERNATIVE YEARS

ℓn Ratings =	α_0	+	$\alpha_1 \ell n$ CU(NI)	+	$\alpha_2 \ell n \frac{LTD}{rA}$	+	$\alpha_3 \ell n$ LTD	R^2	F
1950	1.42		-.084 (-2.72)		-.126 (-1.67)		.031 (2.16)	.45	11.3
1955	1.20		-.031 (-1.03)		-.451 (-5.40)		.037 (3.03)	.49	11.3
1960	.86		.018 (.72)		-.631 (-6.24)		.062 (5.45)	.55	19.3
1965	.67		-.011 (-.37)		-.803 (-6.22)		.059 (5.48)	.62	17.2
1970	1.11		.002 (.11)		-.395 (-4.06)		.051 (3.97)	.20	7.0
1975	1.79		-.042 (-1.61)		-.212 (1.66)		-.018 (-.11)	.12	2.7

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