On the Permanency and Stability of Ratings:

An Analysis of the Origin of Moody's Stock and Bond Ratings

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Introduction

In the aftermath of the Panic of 1907, John Moody published his first railroad[1] security analysis and ratings manual in April 1909.[2] The Poor Company followed in rating securities in 1916 and merged with Standard Statistics in 1941 to form Standard & Poor's (Sylla, 2001). Sylla credits the advent of the securities rating industry as *a fusion of functions performed by* the credit-reporting agency, the financial press and the investment banker. In this paper we find support for this view, but also provide additional rationales for Moody's ratings approach, rooted in the economic and financial-market conditions that characterized the pre-Federal Reserve financial system.[3]

Moody intended his first publication to be primarily a *complete explanation of the proper principles to be employed for analyzing railroad investment values* (Moody, 1909, p. 14), and only secondarily as a ratings-based system of security analysis. Moody's intended audience was the vast number of smaller investors in railroad securities, since control of railroad firms was highly concentrated by 1909.[4] As Moody states:

> *For the railroads are not owned by a small group of capitalists of great wealth, as is erroneously assumed in some quarters, but by a large number (between one and two millions) of individuals in this and other countries, whose average holdings range from $700 to $1,500 each. It is true that the railroad systems are "controlled" by capitalists,*

[1] While the 1909 manual focused on the analysis and rating of railroad company securities, a new volume in 1914 initiated coverage of public utilities and industrials, an additional manual in 1918 covered government and municipal securities, and a 1928 manual covered insurance, financial and investment areas.

[2] The full title of the first manual was: *Moody's Analyses of Railroad Investments Containing in Detailed Form; An Expert Comparative Analysis of Each of the Railroad Systems of the United States, With Careful Deductions, Enabling the Banker and Investor to Ascertain the True Values of Securities; By a Method Based on Scientific Principles Properly Applied to Facts*. Note the particular reference to the *Banker* as one target audience for the analysis.

[3] According to Calomiris and Gorton (2000), "during the period from 1814-1914 the United States experienced 13 banking panics and among these, the Panic of 1907 was the worst." These crises and panics occurred during a period before the U.S. had adopted a formal lender-of-last-resort provider and before the advent of federal market regulation including disclosure requirements.

[4] Control of U.S. railroad lines was concentrated into a few large groups, including the Harriman group, the Gould group, the Morgan "roads", the Hill "lines", and the Rockefeller "properties" (Moody, 1909, p. 60).

> *and in recent years this element of control by small groups has become far more pronounced than was formerly the case; but the actual ownership lies with the investors themselves. Because of this concentrated control it is all the more necessary for the average holder of the stocks and bonds to have proper facilities for ascertaining the real values of investment holdings* (Moody, 1909, p. 12).

Given the limited supply of U.S. government securities at the time,[5] railroad securities were commonly held as bank secondary-reserve investments,[6] and as margin collateral in the NYSE's call loan market. Required margin on call loans was normally 25% of the loan amount, as long as (1) the securing collateral consisted of approximately 2/3 railroad and 1/3 industrial securities, and (2) these securities showed price stability and (more importantly) high liquidity (Griffiss, 1925, pp. 16-26). Sources of call-loan funds included the New York City banks and the interior banks through their correspondent accounts with the New York City banks (Griffiss, 1925, pp. 11-14). These banks would pull funds from the New York call-loan market, and sell off secondary reserve holdings, as seasonal money-demand increased, causing call-loan rates to increase and pressuring bond and stock prices (Seltzer and Horner, 1908).[7] To be able to liquidate during times of crisis, such as the Panic of 1907, the securities held as secondary reserves and as call-loan collateral needed to be of high *security* and *salability*.

The study addresses the following issues. First, current security-rating systems tend to upgrade ratings through business expansions, and conversely downgrade ratings during business

[5] Bank note issues required 100% backing by eligible U.S. government securities. This requirement created some control by the U.S. Treasurer over the U.S. money-supply. As a result of the backing, bank notes were essentially an obligation of the U.S. Treasury. See Friedman and Schwartz (1993, p. 23).

[6] See, for example, the statement by A. G. Hoyt in the National Monetary Commission, A Statistical Study (1910): *The writer was considerably surprised to note that the prices of the standard railroad securities which you selected reflected so accurately the variations in the time money market. My impression is that the explanation may be found in the fact that what might be termed the floating supply of bonds of the character you selected is largely held by banking institutions which carry such bonds as a secondary reserve. Naturally such institutions are sellers when money is in demand and rates are high and there is a consequent depression in the bond market at such times; when the rates for money are low, the converse obtains.*

[7] Seltzer and Horner (1908) showed an inverse correlation between the supply of call loan-market funds by banks and the call loan rate.

contractions, creating a positive cyclicality to ratings and thus credit availability. However, with many railroad bonds with maturities in excess of 50 years in 1909, Moody's analysis likely needed to reflect a longer-term view of security analysis. The study results will show that Moody's bond ratings were largely based on his analysis of the long-run performance of railroad systems.

Second, the study addresses the issue of whether Moody intended his rating system to reflect his private information concerning railroad securities, or simply to capitalize on the transactional economies of providing a convenient source of otherwise publically-available data and security analysis. Like related studies, the present study investigates the accounting factors that explain the ratings systems constructed by Moody.[8] In the present case, the analysis is simpler, since Moody's ratings construction was explicitly based on: (1) the *security* of the issue, reflecting its *security of principal and permanency of income*, and (2) the *salability* of the issue, reflecting its liquidity.[9] The study incorporates these two and other factors, including two factors related to the Panic of 1907, that might give insights into Moody's construction of the first-ever security rating system.

Third, current rating systems tend to reflect an analysis of default probabilities and expected losses. The study investigates this issue through an options-based default analysis, which shows that the default probabilities of railroad firms were quite low, even during the Panic of 1907. Thus, the probability of default was a less likely basis for a security rating system. Indeed, Moody rated 38.94% of railroad securities as *Aaa* and 85.25% of securities as *A*, *Aa* or *Aaa*. Moody based his ratings on an analysis of the risk factors affecting railroad securities, and,

[8] See, for example, Kaplan and Urwitz (1979), Pinches and Mingo (1973), and Pogue and Soldofsky (1969).

[9] As stated by Moody: *Small inactive issues, although well secured in lien and well backed up by heavy earnings, will not sell at as good prices, as a rule, as will those issues on the larger systems which have an established market, and which can be sold on exchanges or to bankers on short notice* (Moody's, 1909, p. 129). Note that Moody suggests that bankers played a dealer type of role in these securities.

in particular, focused on *earnings-power* risk and liquidity risk. By Moody's rating definitions, A-, Aa- and Aaa-rated securities were virtually free of earnings-power risk, and thus were securities affected only by interest-rate risk. These ratings defined a class of *risk-free* securities that likely played a role, as with bank secondary reserve investments and call-loan market collateral, that the limited supply of Treasury securities at the time could not.

Moody's Railroad Security Analysis System

Moody's 1909 railroad analysis focused on two primary characteristics of each railroad security: (1) the ***security*** of the issue and (2) the ***salability*** of the issue. The *security* factor is based on an analysis of a security's claim on railroad earnings relative to its required coupon interest (thus a type of interest-coverage ratio), and is intended to reflect the impact of railroad earnings fluctuations on security value.[10] The *salability* factor, on the other hand, was meant to reflect the security's liquidity, that is, the ability to sell the security without loss of value. As argued above, these two characteristics: *security* and *salability* were of particular importance to investors in 1909, and to banks' secondary reserve decisions and to call loan market conditions and participants, in particular.

The construction of these two factors and the related construction of bond ratings is illustrated in Table I for the *Cleveland, Cincinnati, Chicago & St. Louis Railway*. The first column in the table describes the particular issue. The second column (*Lien on miles*) describes the lien held by a particular issue, in terms of the priority of its claim and the miles of track held under the lien. Column four gives the *interest required per mile of system* (IR) for each particular security listed in the table. For example, in Table I securities (1)-(7) jointly required $581 (that

[10] Interest coverage was a commonly used ratio at the time by investment bankers. For example, J.P. Morgan prominently displayed the ratio in his circulars for new security issues.

is, $20+$155+$151+$100+$73+$15+$67) in interest payments against $2,894 in *average income available* (AIA, column 3), leaving $2,313 in *average income available* for more subordinate claims. The resulting *Factor of Safety* is given in column five, which is calculated as (AIA-IR)/AIA (the interest coverage ratio), and equals 80% for the first seven securities listed in Table I.

The *security* and *salability* factors are then presented in Table I under the title *Basis for Rating*. Bond ratings are given in the final column of Table I and are based on a security's *security* and *salability* factors. Of these two factors, the *security* factor appears to weigh more heavily in determining a particular security's rating. For example, see the ratings definitions given in Table III. However, as emphasized by Moody:

> *It must not be forgotten that arbitrary judgement is used to a large degree in making all these ratings. The percentages showing the factors of safety, etc., serve as a general guide, but the rating given is, in many cases, affected by other considerations not shown in the figures, such as character of management and of traffic, general position of the railroad system, policy of the company in maintenance and other expenses, and in other ways* (Moody's, 1909, p. 194).

In turn, Moody's analysis of *security* and *salability* was based on a long-term railroad performance analysis, as discussed next.

Construction of the Physical Factors, Income Factors and Capitalization Factors

Moody organized his fundamental railroad analysis into three additional tables for each railroad system: (1) *Table A. Physical Factors* presenting data on the railroad's physical assets and revenue sources, (2) *Table B. Income Factors* presenting income-statement information, and (3) *Table C. Capitalization Factors* presenting data on capital sources and their performance.

Each table presents a 10-year data history,[11] along with 10-year averages from similar properties of other railroad systems for comparison. An example of the construction of these tables is given in Table II, again for the *Cleveland, Cincinnati, Chicago & St. Louis Railway*.

The *physical factors* table (panel A of Table II) provides a 10-year history on track mileage, ownership of locomotives and passenger and freight cars, level of annual traffic and the resulting revenues. The data presentation would allow the investor to analyze trends in the railroad's physical expansion and trends in passenger and freight rates and revenues. In the case of the *Cleveland, Cincinnati, Chicago & St. Louis Railway*, railroad trackage and equipment expanded along with *Train Mile Earnings*, while its passenger and freight rates remained relatively flat.

The *income factors* table (panel B in Table II) presents a 10-year history on gross and net earnings, maintenance and other expenses, common and preferred dividends, and balance carried forward. Most importantly, the calculated *Total Net Income* is carried over to Table I to calculate the *Factor of Safety* for the securities with the highest priority lien. As well, the *margin of safety* measure, defined as *the proportion of total net income remaining after payment of all current fixed obligations, including taxes, car trust principal and interest payments, miscellaneous items, etc.* (Moody, 1909, p. 94), is a measure of the security of required interest and other charges.

The *capitalization factor* table (panel C in Table II) provides a 10-year history on major forms of financial capital outstanding, and several capital-performance measures, including margin-of-safety measures for preferred and common stock. The panel shows trends in the railroad company's capital structure decisions, along with trends in return-on-capital (*Net Income*

[11] Specifically, for each railroad system Moody's 1909 manual presented a 10-year history of data abstracted from Interstate Commerce Commission reports. As stated in the manual: *the records of the Interstate Commerce Commission embrace nearly all the facts that are necessary, but they are not presented in very satisfactory form for intelligent and accurate usage* (Moody's, 1909, p. 65).

on Net Capitalization).[12] Preferred and common dividends are listed next. Finally, the *Margin of Safety* measures are listed separately for preferred and common dividends, reflecting the extent that net income exceeded the level of preferred and common dividends paid, respectively. These dividend coverage ratios then apparently served as the basis for Moody's system of stock ratings, as further discussed below.

Permanency and Stability of the Rating System

Moody intended his manual to be a convenient and comprehensive source of data on a railroad's assets, financial results and capitalization, as well as a *complete explanation of the proper principles to be employed for analyzing railroad investment values*. Moody then based the quantitative portion of his railroad analysis on the presented ten-year histories, discussed above. Moody emphasized that the ten-year histories lent *permanency and stability* to his rating system, stating:

> *Many investors in both stocks and bonds were woefully misled by the 1906 and 1907 results of railroads, just as they have since been misled by considering only the bad figures of 1908, and the lack of pronounced improvement in most instances so far in 1909* (Moody, 1909, p. 61).

The use of 10-year averages as a basis for the ratings reduced the cyclicality of the ratings approach. This 10-year average approach would reduce the likelihood of a significant ratings downgrade during periods when a railroad security underperformed its historical 10-year average.

[12] Railroad capitalization was a particular issue at the time. As Moody points out: *No other question in connection with the railroads has agitated the public mind during the recent years as has that of the capitalization of the roads. It is held in many quarters that the railroads of the United States are enormously over-capitalized; that half their bonds represent speculative values and most of their stocks [under] water. And yet a little demonstration can easily show that as measured by earning capacity (the ability to show profits) they are not over-capitalized at all.*

Analytical Basis for Moody's Rating System

Moody based the construction of his rating system on an analysis of the risk factors that affected the pricing of railroad securities. In particular, the rating system was based on a dichotomy between:

(1) High-quality securities: securities whose prices were affected almost exclusively by interest-rate risk. Moody (1909, p. 122) describes these as *Securities which are beyond or above the influences of fluctuating earning power,* and

(2) Lower-quality securities: securities whose prices in addition were affected by changes in the earnings power of the issuing firm. Moody's (1909, p. 122) describes these as *Securities, the values of which are almost exclusively affected by changes in earning power.*

Moody used this risk classification to distinguish "A" rated securities from "B" and "C" rated securities. "A" rated securities tended to be unaffected or little affected by changes in railroad earnings power, while "B" rated securities were somewhat affected, and "C" rated were largely affected (and thus "speculative") by changes in railroad earnings power. Within a particular letter classification, the distinctions become more minor. Thus,

> *In fact, the three ratings, Aaa, Aa and A, can all be regarded as good, and the difference between them are not very great. In a general sense, they are in the class of securities which are affected more by general conditions and changing money rates, than by fluctuations in earning capacity* (Moody, 1909, p. 193).

The distribution of ratings from the 1909 Moody's rating system is given in Panel A of Table IV. What is perhaps surprising is the large number of Aaa-rated securities.[13] 38.94% of securities were rated as *Aaa*, the largest percentage of any rating category. In addition, 85.25% of

[13] In their article: *Oh Where, Oh Where Have the 'AAA's Gone?,* Vazza and Cantor (2002) discuss the current paucity of highly-rated securities.

securities were rated as *A*, *Aa* or *Aaa*. Panel A also shows the frequency distributions of the *security* factor and the *salability* factor.

In addition, panel B and panel C of Table IV shows the cross-tabulation of the bond ratings with the *security* factor and the *salability* factor, respectively. As would be expected, the concentration of ratings lie along the diagonal of the two tables, with the diagonal clustering more concentrated with the *security* factor, reflecting its greater importance in Moody's bond-rating outcomes.

Construction of common and preferred stock ratings

Moody's 1909 approach to ratings included both the bonds, preferred stock and common stock issues of railroad companies. Moody's approach focused on an investment analysis of railroad securities, rather than an analysis-of-default focus, as with current ratings practice. Moody's rationale was simple:

> *While bond and stock issues of corporate undertakings represent, technically, two absolutely distinct classes of obligations, yet through qualification of terms and modification of original forms, these two great classes of securities so blend and interlace in modern corporate finance, that their values as investments must be ascertained largely by the same methods of analysis* (Moody's, 1909, p. 50).[14]

Much less discussion of the establishment of common and preferred stock ratings is given in Moody's 1909 manual. Apparently, these ratings were based on the *Margin of Safety* calculations (a dividend coverage ratio) for common and preferred stock in the capitalization

[14] The 1909 manual also discusses how preferred shareholders might: (1) hold voting rights, at times to the exclusion of other shareholders, (2) be given a lien on property, or (3) share in profits with common shareholders. As well, *There are many railroad bond issues which provide for voting power under certain conditions; there are others which receive their interest only when currently earned by the corporation; there are still others which participate jointly with stock issues in division of certain income* (Moody's, 1909, p. 50). In Moody's opinion, a railroad's fixed-income securities, often secured by liens on particular trackage or other railroad property, benefitted by growth in railroad earnings, just as with common and preferred stock.

section, discussed above. Table V gives the common stock and preferred stock ratings for each railroad company (when available), along with the range of bond ratings for the company. In general, the common stock rating is at the same level or lower than the preferred stock rating, which in turn is at the same level or lower that the lowest of the company's bond ratings, reflecting the pecking order of the claims of these securities. However, several notable exceptions exist in the table.

Analysis of Moody's Bond Rating Assignments

Other studies of bond ratings have investigated various accounting factors that replicate the ratings system used by Moody's and other rating agencies. As discussed above, Moody based his original bond ratings system on two explicit factors: the *security* of the issue, reflecting its *security of principal and permanency of income*, and (2) the *salability* of the issue, reflecting its liquidity. Our analysis first investigates the extent to which these two explicit factors: *security* and *salability* explain Moody's assignment of bond ratings.

In addition, Moody based ratings assignments on his personal judgment concerning individual securities. The study analyzes what factors might have shaped his judgment by incorporating two sets of covariates. First, the study investigates three accounting variables: (1) *leverage*: the ratio of long-term obligations (bonds outstanding plus capitalized leases) to total capital, (2) *profit*: the ratio of net income to total capital, and (3) *size*: total railroad system capital. These accounting ratios have been shown to be predictive in other bond ratings studies. In addition, construction of these ratios is based on the 10-year average results presented in Moody's 1909 manual, to test whether Moody based his judgment on the long-run performance of these railroad lines.

Second, Moody's judgment also might have been shaped by how individual railroad securities reacted during the Panic of 1907, since Moody's first rating manual was copyrighted just some 18 months in the aftermath of the 1907 panic. The analysis examines whether bond ratings reflected the following characteristics of the 1907 panic year: (1) *spread*: a security's high minus low price during 1907 divided by the midpoint, a measure of the security's volatility, and (2) *volume*: the total volume of a security's trading activity during the panic months of October and November 1907. Data on (1) and (2) are taken from the *Commercial and Financial Chronicle*.

The data analyzed consists of the universe of railroad lines analyzed by Moody in the 1909 manual. In addition, for a subset of these securities, the *Commercial and Financial Chronicle* (CFC) published bid and ask prices and weekly trade volume. We refer to this subsample of securities as the CFC rated bond sample. The sample size of these two data samples, and the distribution of bond ratings for each, is given in Table VI. Table VII then gives sample characteristics for the seven explanatory variables discussed above.

The left-hand-side panel of Table VIII presents results of an ordinal regression of Moody's bond ratings on the *security* and *salability* factors, on which Moody explicitly based his ratings assignments. The data analyzed is the universe of railroad firms rated by Moody.[15] As the Table VIII results show, the overall fit of the model is significant with chi-square value of 689.27 (with 10 degrees of freedom). However, the goodness-of-fit analysis indicates that the algorithm had potential convergence problems with this set of regressors. The pseudo R-square measures range from 0.199 to 0.477, depending on the measure used, indicating that these two factors appear to explain a significant amount of the variation in the ratings assignment.

[15] An ordinal regression approach is adopted to account for the ordinal scale of the ratings. In particular, a complementary log-log link function was used, and SPSS was used to perform the regression analysis.

In panel B of Table VIII, three covariates are added to the ordinal regression analysis of panel A, namely (1) *leverage*, calculated as bonds outstanding plus capitalized leases to total capital, (2) *profit*, calculated as net income to total capital and (3) *size*, calculated as total capital. All three covariates are constructed from data on 10-year averages presented in Moody's 1909 manual. With these three additional covariates, the model fit is again statistically significant and the goodness-of-fit analysis no longer indicates convergence problems. The pseudo R-square measures ranges from 0.326 to 0.661, indicating an improvement in the model's explanatory power. The *profit* variable is significant at the 0.001 level and its positive coefficient indicates that more profitable firms achieved higher ratings. The *leverage* variable is marginally significant at the 0.03 level, and its positive coefficient indicates that more leveraged firms realized higher ratings. Finally, the *size* variable does not prove to be a statistically significant predictor of ratings assignment in this context.

The above two ordinal regressions are repeated in Table IX, but now using a subset of the study data that includes only those bonds that were rated and also listed in the *Commercial and Financial Chronicle* (CFC). This data subsample was selected to allow inclusion of two additional covariates related to the Panic of 1907, namely (1) *Spread*, which measures a security's volatility as the percentage spread of a security's high and low prices during the panic year of 1907, and (2) *Volume*, which reflects a security's liquidity during the panic, measured as the total volume of a security's trading activity during the panic months of October and November of 1907. Data on these two variables are taken from the *Commercial and Financial Chronicle*.

In panel A of Table IX, the ordinal regression with just the *security* and *salability* variables is repeated with the CFC rated bond sample. Note in particular that the pseudo R-

square measures now range from 0.644 to 0.893, indicating that these publically-followed and rated firms show more predictable behavior as reflected in the model's explanatory power. As shown in Table VI, the distribution of ratings is comparable in the two samples, so the ratings distribution is not a factor behind the greater explanatory power. Plausibly, the CFC sample is more transparent, in the sense that their published accounting and market information more accurately reflects the quality of these firms.

Finally, the regression analysis of panel A of Table IX is repeated to include the three accounting covariates and the two *Panic-of-1907* covariates. The results are presented in panel B of Table IX. While the covariates: size, leverage and profit are significant, the *Panic-of-1907* covariates are not significant predicators of rating assignment. The implication is that Moody based his ratings assignment on the two explicit factors: *security* and *salability* and the three "judgmental" covariates: *leverage, profit* and *size,* resulting in pseudo R-square measures that range from 0.942 to 0.999. All of these variables, except for the *salability* measure, are based on 10-year average results for each railroad system as presented in the manual. Thus Moody's rating assignments appear indeed to reflect the *permanency and stability* that Moody sought in his rating system.

Railroad Firm Default Analysis

The large percentage of securities that were A-, Aa-, and Aaa-rated, as given in Table IV, suggests that Moody considered default probabilities of railroad securities to be too low to be important in the ratings process. Indeed, in Moody's 1909 manual virtually no attention was given to the issue of security default and the consequent losses. To further examine the issue of default probabilities, the study adopts an options-based procedure by Vassalou and Xing (2004)

to extract default risk measures from the common equity prices of railroad firms, using daily equity quotes listed in the *Commercial and Financial Chronicle*. To construct a robust test of whether default risk was a factor behind security ratings, the study focuses on the year 1907, in particular to examine how the Panic of 1907 impacted default measures, and conversely, the extent to which the Panic of 1907 involved a solvency crisis among listed railroad companies.

Two default risk measures are presented by Vassalou and Xing (2004), namely, the "distance-to-default" (DD), which measures the number of standard deviations from the current value of $\ln(V_A/X)$ to a value of zero (where default occurs), and the default likelihood indicator (DLI), as given below.

$$DD = [\ln(V_{A,t}/X_t)+(\mu-\tfrac{1}{2}\sigma^2_A)T]/(\sigma_A\sqrt{T})$$

$$DLI = N(-DD)$$

Where

$V_{A,t}$ is the value of assets,

X_t is the strike price, that is, the level of liabilities due at the end of the estimation period,

μ is the mean asset return,

σ_A is the volatility of assets,

T is the timeframe of the default likelihood estimation, here taken to be one year, and

N(x) is the cumulative normal distribution to the point x.

Table X lists the sample of railroad firms used in this study and their Moody's bond ratings. The table also lists the minimum and maximum values of the distance-to-default (DD) measure over the study's sample period. Recall that the DD measures the number of standard deviations of $\ln(V_A/X)$ to a value of zero As can be seen in the table, the default measure for most of the companies remained far from any solvency concerns throughout the crisis. The only

railroad firm to reach within two standard deviations of default is Chicago & Alton Railroad, which in fact reached technical insolvency during the crisis. Therefore, these results appear to reject the hypothesis that solvency was a significant factor behind the Panic of 1907 and behind the construction of ratings by Moody in 1909.

Conclusions

Moody's first publication of a security analysis and rating system in 1909 spawned a highly-successful ratings industry. Sylla (2001) credits the advent of this industry as *a fusion of functions performed by* the financial press, the investment banker and the credit-reporting agency. Moody's approach to security ratings included: (1) a focus on historical data that allowed investors to analyze trends in the railroad industry, somewhat like other financial publications, (2) an explicit security analysis system based on a long-run analysis of the *security* and *salability* of railroad securities that created a credible source of information and analysis for investors and (3) a rating system based on the earnings-power and liquidity risks of railroad securities.

Current security-rating systems tend to upgrade ratings through business expansions, and conversely downgrade ratings during business contractions, creating a positive cyclicality to ratings and thus credit availability. However, Moody's intention was to construct a system of ratings that reflected *the element of permanency and stability* (Moody, 1909, p. 61). Moody makes this point as follows.

> *An important question in relation to railroad results and earning power generally, is that of permanency, … What the railroad may have done in the matter of earnings last year, which was a poor year, may be a very poor indication of what it can do in better times or*

> *what it did do in a period of prosperity. And conversely, the "bumper" earnings of 1906 and 1907 may entirely mislead when the question of income in 1908 and 1909 comes to be considered. Many of the issues, which during the years of depression from 1894 to 1897 were selling at low prices, and because of the temporary records of a few years were considered as inferior, would have passed the 10-year test if the earlier years of the period had been included in the general examination of them* (Moody's, 1909, p. 130).

The study's empirical analysis underscores this *element of permanency and stability*. The *security* and *salability* factors, along with accounting ratios reflecting railroad-system leverage, profitability and size, resulted in a regression pseudo R-square measure ranging from 32.6% to 62.9%. These factors, except for salability, were based on the 10-year average performance of railroad lines and thus reflected long-term railroad system performance. In contrast, two *Panic-of-1907* covariates included in the analysis were not significant. The results support Moody's objective of creating a rating system based on the long-term performance of railroad firms, rather than a short-run view of current operating performance.

The study also analyzed the issue of whether Moody's rating system was intended to reflect the default risk of railroad securities, particularly given that the Panic of 1907 occurred just some 18 months prior to the 1909 publication. First, it is likely that Moody chose to focus his first ratings system on the railroad industry because of its low or negligible default risk. Second, Moody rated 38.94% of securities as *Aaa*, and 85.25% as *A*, *Aa* or *Aaa*, reflecting the strength Moody perceived in the railroad industry. Third, the study's options-based default analysis indicates that the majority of railroad securities faced neglible default risk, even during the panic months of 1907. In choosing the railroad industry, Moody was able to define a class of "risk-free" railroad securities. Likely there was substantial demand for such securities, as with the applications mentioned above, namely the demand for high quality securities to serve as

secondary-reserve investments by banks and as collateral in the call-loan market. With the constrained supply of U.S. Treasuries at the time, there was likely substantial demand for railroad bond substitutes.

Finally, the study has addressed the issue of to what extent Moody's rating system reflected his private information concerning railroad securities. The study finds much greater bond-rating predictability for the subsample of rated bonds (365 out of 1137 bonds or 32.1% of the total rated-bond sample) that also were quoted in the *Commercial and Financial Chronicle*. The pseudo R-square measure for this sample ranged from 0.942 to 0.999, while for the universe of rated bonds the pseudo R-square measures ranges from 0.326 to 0.661. The implication would seem to be that railroad bonds followed by the financial press were more transparent in terms of the accounting and liquidity measures of the issuing company. Therefore, the advent of Moody's bond ratings likely had less significance for securities followed in the financial press and greater impact on securities without financial press coverage. This may have created an important historical rationale for the success of bond ratings, since bonds were less liquidly traded and offered less disclosure in 1909. We plan to pursue this topic in future research.

Table I: Construction of the Security and Salability Factors, and the Resulting Bond Ratings

Name of Issue	Lien on Miles	Average Income Available	Interest required per mile of System	Factor of Safety	Basis for Rating Security	Salability	Rating
1. 1st consol 6s	(1st) 175	$2,894	$ 20	80%	VH	H	Aaa
2. 1st 4s	(1st) 170	"	$155	80%	VH	H	Aaa
	(2nd) 175	"					
3. Consol 7s	(1st) 390	"	$151	80%	VH	H	Aaa
4. Gen 6s	(2nd) 390	"	$100	80%	VH	H	Aaa
5. 1st 7s	(1st) 72	"	$ 73	80%	VH	H	Aaa
6. 1st 6s	(2nd) 72	"	$ 15	80%	VH	H	Aaa
7. Consol 5s	(1st) 170	"	$ 67	80%	VH	H	Aaa
8. 1st 4s	(1st) 267	$2,313	$105	64%	H	H	Aa
9. 1st 4s	(1st) 45	"	$ 23	64%	H	H	Aa
10. 1st 4s	(1st) 63	"	$ 13	64%	H	H	A
11. 1st coll 4s	(1st) 194	"	$210	64%	H	H	Aa
12. 1st 4s	(1st) 204	"	$ 84	64%	H	H	Aa
13. Gen 4s	(Gen) 1,117	"	$503	64%	H	H	Aa
14. 1st gtd 5s	(1st) 44	$1,375	$ 63	65%	H	G	A
15. 1st pfd 4s	(1st) 202	"	$ 21	65%	H	G	A
16. 1st pfd 5s	(2nd) 202	"	$ 13	65%	H	G	Baa
17. 1st con 4s	(1st) 150	"	$172	65%	H	G	Baa
	(2nd) 202	"					
18. Income 4s	--- ---	---	$ 84	---	---	-	C
19. 5% notes	Not mtg	$975	$131	65%	---	-	B
20. 1st 4s	(1st) 248	---	$ 21	---	---	-	B

Lien on Miles gives the type of lien: first (1st), second (2nd), general (Gen) or not mortgaged (Not mtg), followed by the number of track miles covered by the lien. In the table, bond issues 1-7 hold the highest claims on Average Income Available (AIA), issues 8-13 hold the second highest claims, followed by issues 14-18, and then by issues 19-20. AIA is the income available to cover the cumulative *Interest required per mile of system* (CIR) under the same level of priority, where AIA is averaged over a 10 year historical period for the particular railroad. The *Factor of Safety* is then calculated as (AIA-CIR)/AIA, e.g., ($2894 - $20-$155-$151-$100-$73-$15-$67)/$2894 = 80%. Note that $2894-$20-$155-$151-$100-$73-$15-$67 = $2,313. The *Security* factor is then assigned, in part based on the *Factor of Safety* value. The security factor takes on designations: Very high, High, Good, Moderate, Fair and Doubtful. The salability factor, which Moody based on the security's trading on the NYSE, takes on designations: Very high, High, Good, Moderate, Fair and Poor. Bond ratings are then assigned, in part, based on the *Security* and *Salability* factors.

The table is abstracted from Table D for the *Cleveland, Cincinnati, Chicago & St. Louis Railway* of Moody's 1909 manual, p. 397.

Table II: Construction of Physical Factor, Income Factor and Capitalization Factor Tables

Table A. Physical Factors (Mileage, Equipment and Operation)

Years Ended	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1898	1838	60	467	380	13311	64%	109351	922851	278	$1.31	1.91c	.54c
1899	1838	60	457	381	13479	62	125455	927549	305	1.43	1.84	.54
1900	1891	60	447	384	15666	65	126911	984442	335	1.65	1.94	.58
1901	1891	80	447	392	18836	65	137101	1009564	332	1.63	1.92	.61
1902	1891	102	451	413	18848	64	154598	1064192	305	1.62	1.88	.59
1903	1891	105	479	422	18836	66	157364	1086783	333	1.68	1.94	.64
1904	1891	143	485	428	19491	62	174156	1029851	329	1.74	1.94	.67
1905	1983	218	558	480	22160	63	165486	1243160	353	1.70	1.90	.60
1906	1983	252	648	498	23857	63	180224	1396284	398	1.80	1.91	.59
1907	1983	301	634	496	23490	65	191084	1548224	425	1.86	1.84	.57

The headings for columns (1) through (12) are: (1) *Average Miles Operated*, (2) *Extra Main Track*, (3) *Locomotives Owned*, (4) *Passenger Cars Owned*, (5) *Freight and Company Cars*, (6) *Freight to all Traffic (%)*, (7) *Passenger Density*, (8) *Freight Density*, (9) *Average Freight Train Load (Tons)*, (10) *Train Mile Earnings*, (11) *Average Rate per Passenger per Mile (Cents)* and (12) *Average Rate per Ton per Mile (Cents)*.

Table B. Income Factors (Earnings and their Distribution, Per Mile of Road)

Years Ended	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1898	$7791	$1037	$1150	$2187	$3454	$2149	$2149	$1959	9%	$190	$204/..	$14
1899	8008	988	1076	2064	3414	2531	2531	1823	28	708	272/..	436
1900	8888	997	1354	2351	3553	2983	2983	1824	39	1158	708/..	451
1901	9154	1197	1369	2566	3854	3033	3100	1866	40	1239	777/247	210
1902	9898	1329	1496	2825	4107	2965	3006	1816	39	1190	856/317	17
1903	10783	1525	1681	3206	4705	2869	2949	1876	37	1073	856/164	53
1904	11112	1440	1628	3068	5396	2678	2766	1899	31	867	856/529	518
1905	11355	1512	1710	3222	5290	2843	2965	2022	32	943	916/..	27
1906	12403	1657	1802	3459	5836	3108	3213	2172	32	1041	1014/..	27
1907	13338	1731	2123	3854	6330	3154	3278	2282	30	996	964/..	32

The headings for columns (1) through (12) are: (1) *Gross Earnings*, (2) *Maintenance: Way*, (3) *Maintenance: Equipment*, (4) *Total Maintenance*, (5) *Transportation General Expenses, etc.*, (6) *Net Earnings*, (7) *Total Net Income*, (8) *Fixed Charges*, (9) *Margin of Safety*, (10) *Surplus over Charges*, (11) *Disposal of Surplus: For Dividends / For Improvements, Etc.* and (12) *Balance Carried Forward*.

Table C. Capitalization Factors (Analysis and Standing of Property)

Years Ended	(1) $/%	(2) $/%	(3)	(4) $	(5) $	(6) $	(7) %	(8) $/%	(9) $/%	(10) $/%
1898	20667/40	30911/60	Nom.	51578	2625	48953	4.4	204/3¾		
1899	20667/40	30909/60	"	51576	2665	48911	5.2	272/5		61/
1900	20088/40	30501/60	"	50582	1809	48780	6.1	264/5	444/3	77/50
1901	20088/40	30088/60	"	50176	1793	48383	6.4	264/5	513/3½	79/47
1902	20316/40	30768/60	"	51084	2177	48907	6.1	264/5	592/4	78/36
1903	20320/39	31294/61	"	51614	2183	49431	6.0	264/5	592/4	75/30
1904	20320/39	31822/61	"	52142	2159	49983	5.5	264/5	592/4	70/
1905	22992/42	31575/58	"	54567	2494	52073	5.7	252/5	664/4	72/3
1906	25214/44	32079/56	"	57293	2516	54777	5.9	252/5	762/4	76/3
1907	28773/45	35105/55	"	63878	3010	60868	5.4	252/5	712/3	74/4

The headings for columns (1) through (12) are: (1) *Stock Outstanding and per cent of Whole*, (2) *Bonds Outstanding and per cent of Whole*, (3) *Rentals Capitalized at 5 per cent*, (4) *Total Gross Capitalization*, (5) *Owned by Company as per Balance Sheet*, (6) *Net Capitalization*, (7) *Net Income on Net Capitalization*, (8) *Preferred Dividend: Amount per mile / Rate*, (9) *Common Dividend: Amount per mile and Rate*, (10) *Margin of Safety Preferred / Margin of Safety Common*.

These panels are taken from Table A (Moody's, 1909, p. 394), Table B (Moody's, 1909, p. 395) and Table C (Moody's, 1909, p. 396) for the *Cleveland, Cincinnati, Chicago & St. Louis Railway*.

Table III: Moody's 1909 Bond and Stock Ratings Definitions

Aaa: *The bonds and stocks which are given this rating are regarded as of the highest class, both as regards security and general convertibility. Practically all such issues are dependent for their prices on the current rates for money, rather than the fluctuations in earning power. In other words, their position is such that their value is not affected, or likely to be affected (except in the cases of stocks not limited as to dividends), by any normal changes in the earning capacity of the railroad itself, either for better or worse.*

Aa: *This rating is given to those issues which, while high-grade, are, in a broad sense, slightly inferior to those having the first rating. Sometimes this inferiority may be in security and sometimes in salability. There is, however, but slight difference between these two classes of securities.*

A: *Bond and stock issues having this rating are affected, to a partial degree, by changing earning power, although they are generally of high grade. No security has been given this rating which is not regarded, as shown by the results of the decade, as being entirely secure, with a permanent and substantial future. In fact, the three ratings, Aaa, Aa and A, can all be regarded as good, and the difference between them are not very great. In a general sense, they are in the class of securities which are affected more by general conditions and changing money rates, than by fluctuations in earning capacity.*

Baa: *Bonds having this rating are generally good, but have a speculative tinge and often are affected to a degree by declines or increases in the earning capacity of the properties. In other words, they are to be regarded, from the investor's standpoint, as good, but second-grade issues.*

Ba: *This rating is given to those issues which make a moderately favorable showing and are regarded as well secured, but are more affected by changing earning power. They stand in danger of declining in value with a falling-off in earnings, but, on the other hand, with great improvements in earnings, are apt materially to advance in strength.*

B: *Issues having this rating are more susceptible to fluctuations, and are to be regarded as more speculative in position than those just mentioned.*

Caa: *Issues which are almost directly responsive to changes in earning power, and have not during the decade had the benefit of available income equal to more than double the interest requirements, are to be regarded in this speculative class.*

Ca: *These issues are less strong in position than those mentioned above, and approach more closely to the field of speculative issues with but moderate security.*

C: *Issues given this rating are those which usually show but a slight margin in surplus above the amount required for their interest, and which are not well secured, or perhaps have not any readily available markets.*

D: *All issues below C are of doubtful character and of almost purely speculative value. There are few such rated in this book, except in the case of stocks, and the differences between them are more those of degree than of character. It is not the purpose of the book to analyze to any pronounced extent the differences between purely speculative securities and, therefore, no attempt has been made to follow the ratings lower than this figure. The vital point has been so to classify and rate the high-grade issues and the good stocks as to give the investor or user of the book an approximate idea of the general position, in a relative sense, of the different investment and semi-investment issues.*

E: *This rating has been given to a few defaulted issues, most of which are awaiting the results of reorganization.*

The ratings definitions are taken from *Moody's* (1909), pp. 193-194. Note that the same rating definitions apply to both stock and bond ratings.

Table IV: Frequencies of Ratings, Security and Salability

The table below gives frequencies (Freq.) and percentages (%) for each category of bond ratings (Rating) and for the security and salability factors, which served as the basis for the bond ratings.

Rating	Freq.	%	Security	Freq.	%	Salability Freq	%	
Aaa	454	38.94	VH	570	48.89	VH	380	32.59
Aa	299	25.64	H	397	34.05	H	538	46.14
A	241	20.67	G	115	9.86	G	121	10.38
Baa	60	5.15	M	9	0.77	M	1	0.09
Ba	52	4.46	F	37	3.17	F	97	8.32
B	32	2.74	D	10	0.86	P	5	0.43
Caa	4	0.34	Unassigned	28	2.40	Unassigned	24	2.06
Ca	10	0.86						
C	9	0.77						
D	3	0.26						
E	2	0.17						
Total	1166			1166			1166	

Bond Ratings Versus the *Security* Factor

The table below gives the frequencies of bond rating versus the security factor, the levels of which are: VH (Very high), H (High), G (Good), M (Moderate), F (Fair) and D (Doubtful).

	Security:					
Rating:	D	F	M	G	H	VH
Aaa	0	0	0	0	13	436
Aa	0	0	0	0	185	113
A	0	0	0	26	185	21
Baa	0	1	0	0	11	0
Ba	0	19	0	48	3	0
B	0	12	3	28	0	0
Caa	0	2	0	1	0	0
Ca	3	1	0	0	0	0
C	4	2	0	0	0	0
D	1	0	0	0	0	0
E	2	0	0	0	0	0

Bond Ratings Versus *Salability* Factor

The table below gives the frequencies of bond rating versus the salability factor, the levels of which are: VH (Very high), H (High), G (Good), M (Moderate), F (Fair) and P (Poor).

	Salability:					
Rating:	P	F	M	G	H	VH
Aaa	0	0	0	0	171	278
Aa	0	1	0	25	209	63
A	0	18	0	71	111	32
Baa	0	17	0	7	32	4
Ba	0	29	0	10	10	1
B	0	17	0	5	5	1
Caa	0	3	0	1	0	0
Ca	1	7	1	0	0	1
C	1	5	0	2	0	0
D	1	0	0	0	0	0
E	2	0	0	0	0	0

Table V: Common-Stock, Preferred-Stock and Range-in-Bond Ratings

Company		Common Stock Rating	Preferred Stock Rating	Bond Rating Range Low	High	# of Rated Bond Issues
1	Alabama & Vicksburg	A	__	Aa	Aaa	3
2	Alabama Great Southern	D	A	A	Aa	3
3	Ann Arbor RR	__	__	Baa	Baa	1
4	Atchison Topeka & Santa Fe	A	Aa	A	Aaa	15
5	Atlantic Coast Line	A	__	A	Aaa	26
6	Baltimore & Ohio	Baa	Aa	A	Aaa	17
7	Bangor & Aroostook	B	__	A	Aa	9
8	Boston & Maine	A	Aa	Aa	Aaa	23
9	Buffalo, Rochester & Pittsburg	Ba	A	Aa	Aaa	7
10	Buffalo & Susquehanna	__	Ca	B	Aaa	3
11	Canadian Pacific	Aa	Aaa	Aa	Aaa	13
12	Canadian Southern	A	__	A	Aa	2
13	Central of Georgia	__	__	A	Aaa	14
14	Central RR & B of Ga	__	__	A	A	1
15	Central RR of New Jersey	Aa	__	Aaa	Aaa	7
16	Chesapeake & Ohio	Ba	__	A	Aaa	16
17	Chicago & Alton RR	Ca	A	A	Aaa	3
18	Chicago, Burlington & Quincy	__	__	Aa	Aaa	16
19	Chicago & Eastern Illinois	__	__	A	Aaa	7
20	Chicago Great Western	E	__	Ca	A	7
21	Chicago, Indianapolis & Louisville	B	Ba	A	Aaa	6
22	Chicago Milwaukee & St Paul	Aa	Aaa	Aaa	Aaa	22
23	Chicago & North Western	Aa	Aaa	Aa	Aaa	31
24	Chicago, R.I. & Pacific	__	__	Ca	Aaa	17
25	Chic St Paul Minn & Omaha	Aa	Aaa	Aaa	Aaa	6
26	Cincinnati, Hamilton & Dayton	__	__	C	Aa	12
27	Cincinnati & Muskingum Valley	__	__	Aaa	Aaa	1
28	Cincinnati, NO & Texas Pacific	Ba	A	B	A	4
29	Cleveland, Akron & Columbus	B	__	Aaa	Aaa	2
30	Clev Cinn Chicago & St Louis	B	A	C	Aaa	20
31	Cleveland, Lorain & Wheeling	__	__	A	Aa	3
32	Colorado & Southern	Ca	Baa (1^{st}) and Ba (2^{nd})	A	Aa	6
33	Conn & Passumpaic Rivers	Aaa		Aaa	Aaa	1
34	Delaware & Hudson	Aa		Baa	Aaa	15
35	Delaware Lackawanna & Western	Aaa	__	Aa	Aaa	12
36	Denver & Rio Grande	C	B	B	Aaa	9
37	Detroit & Mackinac	D	A	Aa	Aa	2
38	Detroit Southern	__	__	E	Ba	4
39	Erie	D	Ca (1^{st}) and C (2^{nd})	B	Aaa	48
40	Evansville & Ind	__	__	A	A	1
41	Evansville & Terre Haute	B	Baa	A	Aaa	8
42	Ft W & Den C	__	__	A	A	1
43	Ft W & Rio Gr	__	__	Ba	Ba	1
44	Georgia, Southern & Florida	C	B&Baa	A	Aa	2
45	Great Northern	Aa	__	Aaa	Aaa	1
46	Gulf & Ship Island	C	__	Baa	A	2
47	Hocking Valley	Baa	A	Aa	Aaa	6
48	Illinois Central	Aa	Aaa	Aa	Aaa	26
49	Iowa Central	D	C	Caa	Ba	3
50	Kansas City Southern	B	A	A	Aa	2
51	Lake Erie & Western	D	Ca	Ba	A	3
52	Lehigh Valley	Aaa	__	A	Aaa	22

53	Long Island	__	__	A	Aaa	17
54	Louisville, Henderson & St. Louis	__	__	A	A	1
55	Louisville & Nashville	Aa	__	A	Aaa	26
56	Maine Central	Aa	__	A	Aaa	28
57	Minneapolis & St. Louis	D	B	Ba	Aaa	8
58	Minn St Paul & Sault Ste Marie	A	Aaa	Aa	Aa	3
59	M S S M & A	__	__	Aa	Aa	1
60	Missouri Kansas & Texas	D	Ba	Baa	Aa	16
61	Missouri Pacific	B	__	Ca	Aaa	23
62	Mobile & Ohio	Ba	__	Baa	Aaa	7
63	Nash Chattanooga & St Louis	Aa	__	Aa	Aaa	8
64	New Orleans & Northeastern	Ba	__	Aa	Aaa	4
65	NY Central & Hudson River	A	__	Ba	Aaa	75
66	NY New Haven & Hartfort	A	__	Baa	Aaa	62
67	NY Ontario & Western	Ba	__	A	Aaa	5
68	Norfolk & Western	Ba	A	A	Aaa	10
69	Northern Central	__	__	Aaa	Aaa	5
70	Northern Pacific	Aa	__	A	Aaa	12
71	Pennsylvania	Aa	__	A	Aaa	48
72	Pennsylvania Company	__	__	A	Aaa	39
73	Pere Marquette	D	C	D	Baa	16
74	Phil, Baltimore & Washington	__	__	A	Aaa	14
75	Reading Company	A	Aaa (1^{st}), Aaa (2^{nd})	A	Aaa	35
76	St Joseph & Grand Island	D	C&Ca	Aa	Aa	1
77	St Louis & San Francisco	D	D&Ca	C	A	31
78	St Louis Southwestern	D	B	B	A	5
79	St Paul M & Man	__	__	Aaa	Aaa	13
80	Sante Fe Press & Ph	__	__	A	A	1
81	Seaboard Air Line	D	C	C	A	21
82	Southern Pacific	A	Aa	A	Aaa	41
83	Southern Railway	D	C	Caa	Aa	42
84	Texas & Pacific	D	__	A	Aaa	4
85	Toledo & Ohio Central	D	C	A	Aaa	5
86	Toledo Peoria & Western	__	__	B	B	1
87	Toledo St Louis & Western	C	Ba	Baa	Aa	2
88	Union Pacific	Aa	Aaa	Aa	Aaa	9
89	Vandalia	A	__	A	Aaa	6
90	Vicksburg, Shreveport & Pacific	A	__	Aa	Aa	2
91	Wabash	D	C	Ba	Aaa	12
92	West N Y & Pa	__	__	Aaa	Aaa	2
93	Wheeling & Lake Erie	E	C (1^{st}) and D (2^{nd})	B	Aa	4
94	Wisconsin Central	C	Ba	Baa	Aa	6

The stock ratings are taken from Moody's *Table of Stock Records and Ratings*, p.195 and the bond ratings aggregated from various tables in the 1909 manual. In general, a railroad's common stock rating is lower than, or equal to, its preferred stock rating, both of which are lower than or equal to the lower rating of the range of its bond ratings. However, there are several exceptions.

Table VI: Comparison of the Moody's Bond Universe and the CFC Rated Bond Sample

Moody's bond universe that was rated covered a much larger sample of railroad bond's than the bond sample reported on by the *Commercial and Financial Chronicle* (CFC), a leading weekly investment journal of the day that reported bond quotes, sale prices and sales volume for selected securities. A bond's coverage in the CFC is likely an important indicator of trade interest in the security.

Moody's Bond Universe

Rating	Freq-uency	Percent	Cumulative Percent
A	232	20.4	20.4
Aa	298	26.2	46.6
Aaa	449	39.5	86.1
B	26	2.3	88.4
Ba	50	4.4	92.8
Baa	60	5.3	98.1
C	7	.6	98.7
Ca	9	.8	99.5
Caa	3	.3	99.7
D	1	.1	99.8
E	2	.2	100.0
Total	1137	100.0	

CFC Rated Bond Sample

Rating	Freq-uency	Percent	Cumulative Percent
A	63	17.3	17.3
Aa	92	25.2	42.5
Aaa	165	45.2	87.7
B	12	3.3	91.0
Ba	17	4.7	95.6
Baa	12	3.3	98.9
C	2	.5	99.5
Ca	2	.5	100.0
Total	365	100.0	

Moody's Bond Universe includes all bonds rated by Moody as given in his 1909 manual. The *CFC Rated Bond Sample* is the sample of railroad bonds reported on in the *Commercial and Financial Chronicle* that were also rated by Moody in the 1909 manual.

Table VII: Sample Characteristics of the Regression Covariates

Moody's Rated Bond Universe

	N	Minimum	Maximum	Mean	Std. Deviation
Size (net capital)	1137	$9,622	$174,460	$71,825	$39,906
Leverage	1137	21.68%	286.44%	81.56%	38.26%
Profit (income_to_capital)	1137	1.10%	18.00%	7.09%	2.63%

CFC Rated Bond Sample

	N	Minimum	Maximum	Mean	Std. Deviation
Size (net capital)	365	$9,622	$174,460	$66,216	$36,461
Leverage	365	21.68%	286.44%	73.23%	27.47%
Profit (income_to_capital)	365	2.10%	12.70%	6.72%	2.59%
Volume	365	0	9,690	148.51	684.81
Spread	365	-3.88%	60.87%	8.59%	8.28%

Sample Means: Moody's Rated Bond Universe

Rating	Sample Size	Net Capital	Leverage	Income to Capital
Aaa	449	76,987	91.56%	8.81%
Aa	298	70,067	78.14%	6.69%
A	232	71,444	74.85%	5.72%
Baa	60	67,997	74.12%	5.85%
Ba	50	62,446	66.64%	4.49%
B	26	51,919	67.78%	4.64%
Caa	3	42,411	64.06%	3.87%
Ca	9	46,030	74.58%	4.92%
C	7	45,136	62.80%	3.99%
D	1	77,721	43.54%	1.10%
E	2	77,721	43.54%	1.10%
Total	1137			

Sample Means: CFC Rated Bond Sample

Rating	Sample Size	Size: Net Capital	Leverage	Profit	Volume	Spread
Aaa	165	70,990	74.57%	8.19%	165	6.76%
Aa	92	62,092	73.44%	6.20%	191	7.13%
A	63	66,062	75.15%	5.17%	50	10.24%
Baa	12	58,054	74.44%	5.06%	69	15.28%
Ba	17	58,079	61.93%	4.15%	152	15.64%
B	12	60,116	62.46%	4.71%	212	15.18%
Caa	0					
Ca	2	44,446	62.86%	4.40%	140	22.29%
C	2	43,505	55.73%	3.5%	29	22.27%
D	0					
E	0					
Total	365					

Moody's Bond Universe includes all bonds rated by Moody as given in his 1909 manual. The *CFC Rated Bond Sample* is the sample of railroad bonds reported on in the *Commercial and Financial Chronicle* that were also rated by Moody in the 1909 manual.

Net capital is taken from Moody's (1909) Table C for each railroad line, and is defined as stock outstanding plus bonds outstanding plus rentals capitalized at 5 per cent minus the company's Treasury securities. *Leverage* is calculated as (bonds outstanding plus rentals capitalized at 5 per cent) divided by net capital. *Profit* is taken from Moody's (1909) Table C for each railroad line, where it is listed as net income on net capital. *Volume* is calculated as the sum of the volume of bonds traded, as reported in the *Commercial and Financial Chronicle*, for the weekly reporting dates: October 4th through November 29th, 1907. *Spread* is calculated as the security's high price minus its low price for the year 1907 divided by the midpoint of this range. The data is taken from the *Commercial and Financial Chronicle* (CFC). As the results above illustrate, the ratings' rank ordering roughly reflects the rank ordering of averages for size, leverage and profit variables, and inversely the rank ordering of averages for spread. Note also that the CFC subsample of bonds is about one third of the size of Moody's rated bond universe, implying that roughly two thirds of this universe is not reported on by the CFC.

Table VIII: Ordinal Regression Analysis of Moody's Rated Bond Universe

Panel A

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1966.978			
Final	1277.709	689.270	10	.000

Goodness of Fit

	Chi-Square	df	Sig.
Pearson	.	220	.
Deviance	.	220	.

Pseudo R-Square

Cox and Snell	.455
Nagelkerke	.477
McFadden	.199

Parameter Estimates

	Estimate	Std. Error	Wald	df	Sig
Threshold:					
[Rating1909 = A]	-2.016	.094	460.714	1	.000
[Rating1909 = Aa]	-.880	.076	134.337	1	.000
[Rating1909 = Aaa]	.671	.062	116.853	1	.000
[Rating1909 = Ba]	1.097	.068	259.975	1	.000
[Rating1909 = Baa]	1.647	.093	312.901	1	.000
[Rating1909 = C]	1.752	.100	308.947	1	.000
[Rating1909 = Ca]	1.919	.112	293.618	1	.000
[Rating1909 = Caa]	1.995	.118	284.312	1	.000
[Rating1909 = D]	2.029	.121	279.722	1	.000
Location:					
[Security=D]	-2.031	.447	20.679	1	.000
[Security=F]	1.322	.212	38.818	1	.000
[Security=G]	1.202	.133	81.354	1	.000
[Security=H]	-1.026	.089	133.190	1	.000
[Security=M]	.585	.385	2.315	1	.128
[Security=VH]	0[a]	.	.	0	.
[Salability=F]	-.117	.158	.554	1	.457
[Salability=G]	-.545	.126	18.653	1	.000
[Salability=H]	-.263	.078	11.331	1	.001
[Salability=M]	-4.676	6.721	.484	1	.487
[Salability=P]	-11.278	.000	.	1	.
[Salability=VH]	0[a]	.	.	0	.

Link function: Complementary Log-log.

a. This parameter is set to zero because it is redundant.

Panel B

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	3051.294			
Final	1923.027	1128.267	13	.000

Goodness of Fit

	Chi-Square	df	Sig.
Pearson	85654.348	2377	.000
Deviance	1783.805	2377	1.000

Pseudo R-Square

Cox and Snell	.629
Nagelkerke	.661
McFadden	.326

Parameter Estimates

	Estimate	Std. Error	Wald	df	Sig.
Threshold:					
[Rating1909 = A]	-1.643	.297	30.587	1	.000
[Rating1909 = Aa]	.633	.284	4.982	1	.026
[Rating1909 = Aaa]	4.621	.347	177.431	1	.000
[Rating1909 = B]	5.199	.360	208.151	1	.000
[Rating1909 = Ba]	6.237	.386	261.329	1	.000
[Rating1909 = Baa]	8.877	.518	293.226	1	.000
[Rating1909 = C]	9.938	.619	257.824	1	.000
[Rating1909 = Ca]	11.828	.887	177.739	1	.000
[Rating1909 = Caa]	13.948	1.516	84.642	1	.000
[Rating1909 = D]	15.486	1.833	71.349	1	.000
Location:					
Size	-9.13E-007	.000	.341	1	.559
Leverage	.004	.002	4.711	1	.030
Profit	.212	.030	50.088	1	.000
[Security=D]	10.171	.857	140.931	1	.000
[Security=F]	5.543	.422	172.661	1	.000
[Security=G]	5.358	.311	296.210	1	.000
[Security=H]	-2.384	.165	208.701	1	.000
[Security=M]	8.547	.798	114.659	1	.000
[Security=VH]	0	.	.	0	.
[Salability=F]	-.806	.281	8.217	1	.004
[Salability=G]	-2.051	.243	71.416	1	.000
[Salability=H]	-.694	.150	21.414	1	.000
[Salability=M]	.011	1.986	.000	1	.995
[Salability=P]	5.291	1.572	11.330	1	.001
[Salability=VH]	0	.	.	0	.

An ordinal regression analysis of bond rating on (1) the security and salability factors that were the explicit basis for rating assignments in the left-side panel, and (2) these two factors plus three accounting covariates: (a) leverage, calculated as bonds outstanding plus capitalized leases to total capital, (b) profit, calculated as net income to total capital and (c) size, calculated as total capital, in the right-side panel. The data analyzed is the universe of bonds rated by Moody in his 1909 analysis of railroad securities.

Table IX: Ordinal Regression Analysis of the CFC Rated Bond Sample

Panel A

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only		673.863		
Final	.000	673.863	8	.000

Goodness of Fit

	Chi-Square	df	Sig.
Pearson	.[a]	125	.
Deviance	.[a]	125	.

a. Floating point overflow occurred while computing this statistic. Its value is therefore set to system missing.

Pseudo R-Square

Cox and Snell	.842
Nagelkerke	.893
McFadden	.644

Parameter Estimates

	Estimate	Std. Error	Wald	df	Sig.
Threshold :					
[Rating1909 = A]	-2.285	.169	182.316	1	.000
[Rating1909 = Aa]	-1.071	.128	70.076	1	.000
[Rating1909 = Aaa]	.773	.095	66.622	1	.000
[Rating1909 = B]	.989	.100	97.592	1	.000
[Rating1909 = Ba]	1.340	.119	126.492	1	.000
[Rating1909 = Baa]	1.757	.164	114.392	1	.000
[Rating1909 = C]	1.887	.183	106.588	1	.000
Location:					
[Security=D]	-7.855	.000	.	1	.
[Security=F]	1.486	.329	20.456	1	.000
[Security=G]	1.327	.253	27.424	1	.000
[Security=H]	-1.241	.168	54.804	1	.000
[Security=M]	1.305	.641	4.147	1	.042
[Security=VH]	0[a]	.	.	0	.
[Salability=F]	-.526	.405	1.691	1	.193
[Salability=G]	-.274	.274	.999	1	.318
[Salability=H]	-.499	.148	11.407	1	.001
[Salability=VH]	0[a]	.	.	0	.

a This parameter is set to zero because it is redundant.

Panel B

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only		1039.391		
Final	.000	1039.391	13	.000

Goodness of Fit

	Chi-Square	df	Sig.
Pearson	73295.694	2444	.000
Deviance	652.353	2444	1.000

Pseudo R-Square

Cox and Snell	.942
Nagelkerke	.999
McFadden	.993

Parameter Estimates

	Estimate	Std. Error	Wald	df	Sig.
Threshold:					
[Rating1909 = A]	-2.359	.592	15.858	1	.000
[Rating1909 = Aa]	.162	.550	.087	1	.768
[Rating1909 = Aaa]	4.767	.693	47.326	1	.000
[Rating1909 = B]	5.714	.729	61.482	1	.000
[Rating1909 = Ba]	7.080	.784	81.497	1	.000
[Rating1909 = Baa]	20.524	206.790	.010	1	.921
[Rating1909 = C]	34.801	618.018	.003	1	.955
Location:					
Size	6.76E-006	.000	4.410	1	.036
Leverage	-.009	.005	3.795	1	.051
Profit	.253	.062	16.752	1	.000
PercentSpread	-.001	.015	.007	1	.934
TotalVolume	3.75E-005	.000	.050	1	.824
[Security=D]	35.078	618.018	.003	1	.955
[Security=F]	5.999	.711	71.198	1	.000
[Security=G]	5.823	.612	90.424	1	.000
[Security=H]	-3.008	.328	84.093	1	.000
[Security=M]	5.044	1.218	17.137	1	.000
[Security=VH]	0[a]	.	.	0	.
.	.				
[Salability=F]	-1.138	.695	2.684	1	.101
[Salability=G]	-1.377	.495	7.733	1	.005
[Salability=H]	-.777	.266	8.525	1	.004
[Salability=VH]	0[a]	.	.	0	.

a This parameter is set to zero because it is redundant.

An ordinal regression analysis of bond rating on (1) the security and salability factors that were the explicit basis for rating assignments in the left-side panel, and (2) these two factors plus three accounting covariates: (a) *Leverage*, calculated as bonds outstanding plus capitalized leases to total capital, (b) *Profit*, calculated as net income to total capital and (c) *Size*, calculated as total capital, and two Panic-of-1907 covariates: (1) *PercentSpread*, calculated as the percentage spread of a security's high and low prices during 1907, a measure of the security's volatility, and (2) *TotalVolume*, calculated as the total volume of a security's trading activity during the panic months of October and November of 1907, in the right-side panel. Data on these latter two variables were taken from the *Commercial and Financial Chronicle*. The data analyzed are those rated railroad bonds that were also listed in the *Commercial and Financial Chronicle*.

Table X: Distance-To-Default (DD) Measure Results

Railroad Company	Moody's 1909 Bond Rating	DD Measure stated as the number of st. dev's., over 6/29/1907-12/27/1907 Min	Max
(1) Atcheson Topeka & Santa Fe RR	A-Aaa	78	107
(2) Atlantic Coast Line RR	A-Aaa	46	75
(3) Baltimore & Ohio RR	A-Aaa	84	110
(4) Canadian Southern RR	A-Aa	38	47
(5) Central of New Jersey RR	Aaa-Aaa	78	93
(6) Chesapeake & Ohio RR	A-Aaa	28	44
(7) Chicago & Alton RR	A-Aaa	-0	8
(8) Chicago Mil & St Paul RR	Aaa-Aaa	104	135
(9) Chicago & North Western RR	Aa-Aaa	174	196
(10) Chicago St P Minn & Omaha RR	Aaa-Aaa	74	86
(11) Colorado & Southern RR	A-Aa	26	47
(12) Delaware & Hudson RR	Baa-Aaa	107	132
(13) Delaware Lack & Western RR	Aa-Aaa	159	172
(14) Denver & Rio Grande RR	B-Aaa	16	34
(15) Duluth So Shore & Atlantic RR	Unrated	5	15
(16) Erie RR	B-Aaa	19	48
(17) Illinois Central RR	Aa-Aaa	114	134
(18) Iowa Central RR	Caa-Ba	15	34
(19) Kansas City Southern RR	A-Aa	28	39
(20) Lake Erie & Western RR	Ba-A	12	22
(21) Louisville & Nashville RR	A-Aaa	92	118
(22) Minneapolis & St Louis RR	Ba-Aaa	12	36
(23) Minn St P & S S Marie RR	Aa-Aa	42	68
(24) Mo Kansas & Texas RR	Baa-Aa	31	59
(25) Missouri Pacific RR	Ca-Aaa	52	80
(26) Nash Chatt & St Louis RR	Aa-Aaa	63	77
(27) N Y Central & Hudson River RR	Ba-Aaa	122	145
(28) N Y Chic & St Louis RR	Unrated	14	32
(29) N Y N Haven & Hartfort RR	Baa-Aaa	98	120
(30) N Y Ontario & Western RR	A-Aaa	80	99
(31) Norfolk & Western RR	A-Aaa	81	103
(32) Pacific Coast Co	Unrated	43	62
(33) Pennsylvania RR	A-Aaa	253	276
(34) Pittsb Cin Chic & St L RR	Unrated	36	48
(35) Reading Co.	A-Aaa	72	95
(36) St Louis Southwestern RR	B-A	7	23
(37) Southern Pacific Co	A-Aaa	104	128
(38) Texas & Pacific RR	A-Aaa	14	26
(39) Union Pacific RR	Aa-Aaa	64	81
(40) Wabash RR	Ba-Aaa	7	24
(41) Wheel'g & Lake Erie RR	B-Aa	4	16
(42) Wisconsin Central RR	Baa-Aa	5	17

The table presents results from a Vassalou and Xing (2004) default-risk analysis to extract default risk measures from the common equity prices of railroad firms with daily equity quotes. The DD measure gives the estimated distance-to-default, in terms of the number of standard deviations (st. dev's.) from the current value of $\ln(V_A/X)$ to a value of zero (where default occurs). DD is measured as $[\ln(V_{A,t}/X_t)+(\mu-\frac{1}{2}\sigma^2_A)T]/(\sigma_A\sqrt{T})$, where $V_{A,t}$ is the value of assets, X_t is the strike price, that is, the level of liabilities due at the end of the estimation period, μ is the mean asset return, σ_A is the volatility of assets, and T is the timeframe of the default likelihood estimation, taken to be one year.

Min is the minimum, and Max is the maximum, distance-to-default (DD) measure for each stock over the period: 6/29/1907-12/27/1907.

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