A Reexamination of the Investment Performance of Junk Bonds

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Abstract

This paper reexamines the investment performance of junk bonds relative to that of corporate bonds in general. Bond ratings are highly correlated with promised yield to maturity for bonds of all quality classes, but are not strongly correlated with realized risk-adjusted return. The previously reported superior performance of junk bonds is shown to be a result of confusing promised yield with realized performance. Those investors who value results more highly than promises will need more information than the bond rating and promised yield to maturity.

Introduction

The roller coaster ride of the junk bond market over the past several years has stimulated continued interest and research focusing upon the investment quality of junk bonds and the overall efficiency of the bond market. Earlier research generally concludes that junk bonds have been undervalued because annual default rates are less than the initial yield spreads over investment grade bonds. These early works, however, are flawed by methodological errors. Following the fall of the junk bond market and the demise of Drexel Burnham Lambert, two recent studies conclude that junk bonds have not been undervalued. Unfortunately, these recent studies also suffer from various methodological flaws. The possibility exists, therefore, that additional studies may reach still different conclusions. The end result is that the investment quality of junk bonds remains unresolved. The current research reexamines the investment performance of junk bonds (relative to the overall performance of corporate bonds) using correct methodological procedures that will enable this issue to be resolved.

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The main methodological error of the earlier works (typified by Altman, 1987) is that these works impute a return to a bond based upon the promised yield to maturity net of principal losses and coupon income foregone based on default probabilities.[1] Such measures of return fail to recognize the two largest components of total bond return variability: capital gains and losses resulting from changes in the overall level of interest rates and reinvestment of coupons received at the current level of return which may differ substantially from the promised yield to maturity. Recent works address these problems, but contain other methodological errors. Cornell and Green's (1991) primary methodological flaw is that their junk bond portfolios include substantial proportions of risk free and investment grade bonds. Blume, Keim, and Patel (1991) assume coupons are reinvested across the portfolio, whereas the Center for Research in Security Prices (CRSP) and modern stock market studies assume income is reinvested in the specific asset producing the income. The current research corrects these problems by constructing portfolios consisting of bonds from only one rating category and computing portfolio returns consistent with the practices used in modern studies of the stock market.

Controlling for interest rate and systematic market risks shows that the corporate bond market was efficiently priced from 1981 to 1988. The results also indicate that bond ratings are highly correlated with promised yield to maturity, but not strongly correlated with realized returns.

Related Previous Studies

Altman and Nammacher (1987) and Altman (1987) examine the yield to maturity and the realized return for junk bonds from 1979 to 1986. Their samples include the entire population of corporate junk bonds outstanding, including transportation, utilities, and financial firms. Bonds originally issued as non-investment grades and fallen angels are combined in their analyses. Their studies conclude that junk bonds have both higher promised yields and higher realized yields than investment grade bonds.[2] They do not examine, however, whether the higher returns outweigh the (presumably) higher *ex ante* risks.

Altman (1989) utilizes the mortality rate concept to look at the compounded return of various grades of bonds from 1971 to 1987. His simulation study based on historical yield spreads and mortality rates concludes that junk bonds' total

[1] Other studies examining default rates of bonds include Hickman (1958), Fraine and Mills (1961), and Fitzpatrick and Severiens (1978) who also conclude that experienced default rates may have been less than initially expected when compared with promised yields to maturity.

[2] They define realized yield to be the promised yield to maturity minus the experienced default rate times the sum of the average capital loss from issue to default and one half year's current income.

returns would be greater than the returns of higher grade bonds over a long-term investment horizon, despite the higher default rate of junk bonds. Altman characterizes the greater return as *outperformance*, but does not consider the volatility of return over subintervals. In simulating his returns, Altman does not consider unrealized capital gains and losses, and he assumes that the received coupons are reinvested at the then current yield to maturity for similarly rated bonds.

Asquith, Mullins, and Wolff (1989) perform an aging analysis of defaults, exchanges, and calls from 1977 to 1986. They suggest that the annual default rates reported by earlier researchers have masked the fact that over the life of junk bonds one-third will default, others will be exchanged for other securities (often as a result of financial distress), while most of the surviving high yield debt will be called prior to maturity.[3,4] Although Asquith *et al.* do not examine investment returns, they suggest future research should focus on realized performance.

Blume and Keim (1987) find that equally weighted portfolios of junk bonds have higher returns and similar beta risk compared with higher grade bonds from 1977 through 1986. Blume and Keim find that the market model betas of bonds relative to the S&P 500 are .30 for junk bonds and .37 for higher grade bonds. They did not control for overall changes in interest rates and differences in sensitivity to interest rate movements.[5] Blume, Keim, and Patel (1991) reexamine Blume and Keim's earlier study in an attempt to explain the anomalous low volatilities of junk bonds, with the view that embedded call premia are a primary factor. Blume, Keim, and Patel (1991, footnote 23) state that their methodology results in a defaulting bond (even if it becomes *entirely* worthless) potentially having a positive realized return! (emphasis added). This results from both studies assuming that some coupons from high yielding bonds (those more likely to default) are reinvested in lower yielding bonds with less default risk (and vice versa); this will result in upwardly biased estimates of portfolio return. Despite this bias, the 1991 paper finds no evidence of mispricing of junk bonds.

Cornell and Green (1991) investigate the investment performance of lower grade bonds by observing monthly changes in net asset value (NAV) for open-ended low grade mutual funds as their measure of return for junk bonds. These funds may not be representative of junk bonds, however, because they state

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[3]Van Horne (1980) finds the realized yield to maturity for bonds that are called by refunding to be greater than that for similar bonds that are not called. This is because the called bonds earned higher coupons during their life (which results in their being called). Van Horne concludes that investors are rewarded adequately for call risk.

[4]Ma and Weed (1986) find that the yields to maturity of junk bonds issued for corporate takeovers are similar to those of other corporate junk bonds.

[5]Baskin and Crooch (1968), Weinstein (1987), Joehnk and Nielsen (1975), and Chandy and Cherry (1983) also examine various return measures for low grade bonds. None of these earlier papers explicitly controls for the expected sensitivity of bond prices to interest rate changes.

(p. 31) that at least two-thirds of the portfolios must be invested in grades Baa or lower to qualify. Baa bonds commonly are recognized to be investment grade bonds. Furthermore, the use of the volatility of NAVs as a proxy for the volatility of junk bonds must be questioned. As noted by Cornell and Green (p. 34 and footnote 11), a significant portion of the investments of the mutual funds are in low risk, cash-equivalent instruments. This means that the volatility of the total fund likely will be less than that of the riskier bonds in the portfolio. Second, the NAVs themselves are derived from matrix-prices, which Asquith *et al.* (1989) note are incapable of capturing event risk. Furthermore, the mutual funds are not passive portfolios; thus, the changes in NAV reflect changes in portfolio composition. Mutual fund managers' decisions on maturity/duration, quality, and industry effects introduce additional confounding factors to a study of junk bonds. Thus, the mutual fund NAVs used by Cornell and Green are unlikely to capture the returns to an unmanaged portfolio of noninvestment grade securities. All of these problems result in less powerful tests of the efficient market hypothesis and may be the cause of their conclusion that low grade bonds are priced fairly.

These 1991 studies, therefore, although correcting the obvious methodological flaws of the earlier works, contain serious methodological errors of their own. This research will address these issues in reexamining the performance of junk bonds. Specifically, it is assumed that the high yield coupons are reinvested in the same high yield (high risk) bonds, consistent with the practices of CRSP for computing stock returns. Furthermore, the junk bond portfolios comprise strictly junk bonds. This is a result of an experimental design that groups junk bonds into portfolios based upon their rating classification. By providing returns on each rating class of bonds, it is possible to test whether risk-adjusted returns are jointly consistent across rating groups. This joint testing of different bond ratings is also novel. By addressing these issues, the present study closes an important gap in the existing literature.

Data

The lack of reliable, computer-readable corporate bond price data undoubtedly has been a factor in the relative paucity of bond market efficiency studies compared with the rich literature for the stock market. There are three alternative sources for data, each with potential problems in an empirical study. One source of data is Standard & Poor's *Statistical Survey* which lists the yield to maturity for newly issued bonds of each rating class. The primary drawback to using this source is that it lacks data on such important variables as the initial coupons, maturities, and portfolio mixes necessary to impute price changes of seasoned bonds. A second source is the bond indexes provided by various brokerage houses, such as Salomon Brothers or Drexel Burnham. These indexes are composed from actual dealer quotes, but the composition of the index is subject to frequent and undetermined changes. Bonds that default are likely to be dropped from these indexes.[6] Thus, the indexes may overstate materially the investment returns possible. The third possibility is to identify a time-coherent group of bonds that could be purchased by an investor at a point in time and follow these portfolios over time. In addition to being more consistent with a bond investor's concerns, this approach has the advantage of more closely controlling for external confounding factors such as greatly differing coupons. Although it increases the data collection effort, the third approach is selected for the current research.

The sample initially consisted of 341 nonconvertible industrial bonds issued from 1975 to 1980. (For more details on this sample, see Ederington, 1986.)[7] This represents all of the newly issued nonconvertible industrial bonds that received a Moody's rating in this period. Unlike Blume *et al.* (1991) who include a substantial number of transportation and financial bonds in their study, the present study includes only industrial bonds because Ederington and Yawitz (1987, pp. 34, 36) note that bond rating standards for nonindustrials may differ from those for industrial issues. Also, S&P maintains different indexes for utility, financial, transportation, and industrial bonds. Because one of the objectives of this research is to contrast the risk-return tradeoff for different categories, the bonds should be stratified on a consistent criterion (in this case, bond rating). Convertible bonds are excluded because of the confounding nature of their equity components. Data on rates, maturities, ratings, and monthly prices from 1981 to 1988 are collected from monthly editions of *Moody's Bond Record*. Data on 276 of the aged bonds in this cohort group are available in the January 1981 issue of *Moody's* for consideration as investments.

The prices quoted in *Moody's* are the last transaction prices of the month for bonds listed on an exchange and dealer bid prices for unlisted bonds. To the extent that lower rated bonds are less likely to be traded on an exchange and have lower liquidity, the larger bid-ask spreads on these bonds will result in returns (computed using bid prices) being too high for junk bonds relative to higher rated bonds with smaller bid-ask spreads. The use of matrix-generated prices, advocated by Nunn, Hill, and Schneeweis (1986) was rejected as an alternative to *Moody's* because matrix prices are inherently unable to incorporate event risk. Matrix-generated prices impute an *ex ante* risk premium to each asset based on an analysis of perceived risks. This means that returns computed from matrix-generated prices will capture the *ex ante* risk premium spuriously even if the true

[6]Blume and Keim drop bonds from their index two months after a default.

[7]Asquith *et al.* (1989, p. 938) state that "there is no evidence suggesting a fundamental change in the nature of the market" for the bonds used in this study versus more recently issued junk bonds.

market price does not reflect the *ex ante* premium. Thus, tests for a risk-return tradeoff using matrix-generated prices will be biased toward accepting the stipulated tradeoff.

Also, Blume and Keim (1987) note that the prices quoted by Salomon Brothers (used in their study) are based on minimum quantities of 500 bonds. This would represent a sizable portion of the total issue for many of the bonds in this study. Given the illiquid nature of such blocks, the bid prices used in Blume, Keim, and Patel (1991) and Blume and Keim (1987) are expected to be biased severely downward from the equilibrium prices, resulting in a substantial upward bias in returns computed from such prices.[8] Thus, the returns computed in these studies may overstate the potential returns available to an investor in junk bonds significantly.

Monthly holding period returns to each bond are computed in a manner consistent with CRSP's well-established practices for stock returns. First, called bonds are valued at the call price. Second, exchanges are valued at the market value of securities received in the exchange. Third, defaulting issues are continued in the data base as long as prices are available. When prices are no longer available for any bond, the last price found is used. Fourth, monthly returns for each bond are combined into an equally weighted portfolio. Thus, proceeds from extinguished issues are assumed equally reinvested in the remaining bonds in the portfolio. Previous studies of junk bonds do not compute their returns in this manner. The methodologies used by Altman (1987) and Blume *et al.* (1991) result in substantially upwardly biased measures when compared with measures used by researchers in the stock market. Their measures are upward biased because they assume unrealistically high reinvestment rates (such as the promised yield to maturity (IRR)) and fail to recognize that the reinvested coupons on defaulting issues lose value in the same proportion as the defaulting principal.

On the other hand, the current procedures mimic Fisher and Lorie's (1977) CRSP standards; the results should be readily interpretable. In particular, computing bond returns in the same manner as the stock market index used for systematic risk adjustment is critical, a point established by Zivney and Thompson (1989).

Data also were collected to provide measures of interest rate movements and stock market returns necessary to adjust for marketwide risk. Monthly data on U.S. government bond yields and returns, together with monthly returns to a value-weighted stock market index, were obtained from Ibbotson Associates' *Stocks, Bonds, Bills, and Inflation 1989 Yearbook.*

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[8] Several articles in *Barron's* confirm this problem with matrix pricing.

Methodology

This study investigates the behavior of junk bonds compared with other categories of bonds. Accordingly, six portfolios are constructed corresponding to Moody's ratings of the bonds (Aaa, Aa, A, Baa, Ba, and B) as of the end of 1980. No bonds with an initial rating from Moody's of Caa or lower were issued in the period 1975-1980. Consistent with Blume and Keim (1987), monthly returns for each equally weighted portfolio are computed as the average of the individual bonds' returns. Multiperiod returns are computed as in Heinkel and Kraus (1988) by assuming prices evolve continuously over the nontrading interval. The returns of the portfolios are analyzed to determine whether the *ex post* returns are consistent with the *ex ante* risk assessments provided by Moody's.

Moody's ratings, however, are not designed to reflect risks related to interest rate movements or general stock market conditions. Therefore, a standard two factor model is used to adjust the raw bond returns to control for the impact of these systematic risks. The primary factor affecting bond returns is overall interest rate changes. This should be the only sensitivity faced by risk free bonds. Second, risky bonds' returns may be related to the overall performance of their issuers. A stock market index is used as the second factor to reflect the sensitivity to business default risk.

The first factor considered in this study is the effect of interest rates. This factor removes that portion of the return caused by general market interest rate movements in a manner analogous to the way the market model removes the impact of systematic market movements in studies of abnormal returns on stocks. The second systematic factor considered is the stock market return. Corporate bond returns may be correlated with stock market movements because lower values of stock prices increase the probability that shareholders may exercise their option to default on the outstanding debt. Thus, corporate bond returns should be correlated positively with a stock market index, even after the bond returns have been purged of interest rate sensitivity. The resulting theoretical return model is:

$$(1)\ R_{it} = \alpha_i + C_{Tt} - D_{it}\left[\frac{dI_t}{1+I_t}\right] + \beta_i R_{mt} + \varepsilon_{it}$$

where:

R_{it} = Total return (accrued and realized interest plus capital gain or loss) on the corporate bond;

α_i = Risk-adjusted return of the bond;

C_{Tt} = Current coupon yield on a risk free par bond;

D_{it} = Macaulay's duration of the corporate bond;
I_t = Yield to maturity of the risk free par bond;
β_i = Beta or systematic risk of the corporate bond relative to a stock market index; and
R_{mt} = Return on a stock market index.

Rearranging equation (1), the resulting equation is estimated:

$$(2)\ R_{it} - C_{Tt} + D_{it}\left[\frac{dI_t}{1+I_t}\right] = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

where:

α_i = Estimate of the risk-adjusted return of the corporate bond controlled for both interest rate risk and stock market related risk.

If interest rate and stock market sensitivity are the only factors priced by the market, then the expected value of the intercept will be zero. Thus, the estimated intercept is directly analogous to the Jensen's alpha commonly computed as a performance measure for stock portfolios. This research tests for the intercepts to be equal across bonds of different ratings. $\alpha_i \neq \alpha_j$ implies that risks other than interest rate and stock market risks are priced in the market or that the market is inefficient.

Because most bonds trade relatively infrequently compared with a common stock or government bond index, problems may arise from nonsynchronous trading of the industrial bond portfolios. One problem related to this Fisher (1966) effect is that the computed variance of returns will be downward biased. Thus, the standard deviations of returns reported below for junk bonds will tend to be understated. In addition, the systematic risk of the infrequently traded bonds will tend to be biased downward. Ibbotson (1975) and Dimson (1979) find that adding lagged explanatory variables reduces this problem. Therefore, one and two month lagged interest rate variables, $dI/(1+I)$, and one and two month lagged stock market variables, R_m, were added to equation (2) to produce unbiased estimates of the intercept.

The duration measure used in equations (1) and (2) assumes that the bonds are free of default risk. Bierwag and Kaufman (1988) show that the duration of nondefault-free bonds may be either longer or shorter than the Macaulay durations usually computed. If default is expected to happen soon, the sensitivity to interest rate movements will be greater than anticipated from using Macaulay's duration. Conversely, if default is not expected until late in the life of the bond, the bond will be less sensitive than will a risk free bond of similar Macaulay duration. To accommodate the uncertainty in interest rate sensitivity resulting from the risk of default, one could modify equation (2) into equation (3):

$$(3)\ R_{it} - C_{Tt} - \delta_i \left[\frac{dI_t}{1+I_t}\right] = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

where:

δ_i = Estimated sensitivity to changes in the risk free interest rate, I.

δ_i is estimated as the slope coefficient computed by regressing R_{it} on $dI_t/(1+I_t)$. Unfortunately, δ_i estimated from an ordinary least squares regression will not reflect the time-varying nature of the bonds' true interest rate sensitivity correctly. The time-varying nature is due to two factors: a systematic shortening of duration as the bond approaches maturity with the passage of time and a random component due to changes in the level of interest rates. Both of these factors may be controlled for by estimating equation (4):

$$(4)\ R_{it} - C_{Tt} - (\delta_{it} + \tau_i \bullet t)\left[\frac{dI_t}{1+I_t}\right] + \theta_i \bullet I_t = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

where τ_i adjusts for the systematic shortening of duration over time, t, and θ_i controls for the variation in interest rate levels.

The return on T-bonds can be used as a proxy or instrumental variable in place of $\theta_i \bullet I_t$ in equation (4) as another alternative for controlling for the changes in interest rate sensitivity. This procedure capitalizes on the fact that both the systematic shortening of duration with approaching maturity and the random component related to interest rate changes are faced by all long-term bonds. The returns on the risk free government bonds also exhibit sensitivity to interest rate levels. Addressing these concerns, equation (5) may replace equation (4):

$$(5)\ R_{it} - \Sigma\delta_i \left[\frac{dI_t}{1+I_t}\right] - \Sigma\theta_i R_{Tt} = \alpha_i + \Sigma\beta_i R_{mt} + \varepsilon_{it}$$

where:

R_{Tt} = Return on long-term treasury bonds from Ibbotson Associates (1989);

δ_i and θ_i = Estimated by regressing their respective explanatory variables on R_{it}, and

Σ = Term that indicates that two monthly lags are used in addition to the contemporaneous explanatory variables.[9]

Results

Table 1 presents summary statistics on monthly holding period returns and average yield to maturity over the 96 month *ex post* analysis period, 1981-1988. No further analysis is performed on the Ba-rated bonds because their number in the sample declines from 12 to only five over the test period. Table 1 demonstrates the expected increase in promised yield to maturity corresponding with a decrease in quality. The realized returns to an investor in the lower rated bonds over the period, however, are substantially less than the promised yields and even lower than the returns to those holding the less risky Baa investment-grade bonds. Thus, although the rating process correlates well with yields, it does not predict *ex post* returns or risk nearly as well.

The annualized average realized return in Table 1 is greater than the average yield to maturity (with the important exception of B grade bonds) because the period of analysis is characterized by generally falling interest rates.[10] The amount of realized return in excess of promised yield is greater for the investment grade bonds. This reflects several factors. First, the Macaulay durations of the higher grade bonds are slightly greater, resulting in greater interest rate sensitivity. This greater interest rate sensitivity also is captured in the higher standard deviations of return for the highest grade bonds over the average bonds. Second, the lower rated bonds are more likely to default. Actual defaults will lower the realized returns. The higher standard deviations of returns for the junk bonds vis—á—vis the average bonds is due in part to the greater frequency of defaults by the junk bonds. Third, the nondefaulting lower rated bonds with their larger coupons are more likely to be called than the higher rated bonds. The government bonds are virtually call-risk free. The higher call rate of the lower rated bonds also contributes to the higher standard deviations of returns for the junk bonds. When a bond is called, future potential capital gains (and, usually, substantial current income) are foregone. Fourth, Asquith *et al.* note that bonds with increasing default probabilities over their lives naturally will tend to sell at a discount in their early lives. This provides another source of variability for junk bonds while lowering the realized returns. Finally, the sensitivity of the lower rated bonds to movements in the stock market may be greater than for less risky bonds.

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[9] τ from equation (4) is found to be statistically insignificant in empirical tests.

[10] The same is true in Hickman's study. See his Table 1.

The first hypothesis tested is that realized returns adjusted for overall interest rate movements increase as the quality decreases. A glance at Table 2 confirms that these realized adjusted returns are correlated strongly with bond ratings for the investment grade bonds (Aaa, Aa, A, and Baa). Spearman rank correlation coefficients are computed for the adjusted returns and bond ratings in Table 2. The correlation coefficient of .9 for Moody's ratings versus average adjusted returns is significant at the 1 percent level. Similarly, the rank correlation between ratings and standard deviations of returns (.9) is also significant at the 1 percent level. Thus, there appears to be a statistically significant risk-return tradeoff in the industrial bond market. The appropriateness of the risk-return tradeoff is examined later.

The standard deviations of adjusted returns reported in Table 2 display a monotonic relationship between *ex post* adjusted return and standard deviation. Because adjusted returns are purged of the variability due to interest rate movements, the standard deviation of adjusted returns reflects the other risks that the rating agencies try to quantify. Moody's ratings properly have ranked the bond portfolios by this measure of noninterest-rate risk for the investment grade bonds.

Table 2 stands as an alternative explanation to that of Blume *et al.* (1991) who focus on explaining the relatively low volatility for junk bonds previously reported in Blum and Keim (1987). They compute theoretical values for the call premium as the primary factor for the low volatility of junk issues. Asquith *et al.* (1989) note the difficulty of computing the value of the call option on lower grade bonds because of the possibility of upgrading and the larger inherent equity component. Adjusting for duration (Table 2) is sufficient to put the relative volatilities of various grades of bonds in the expected order. The factors that cause junk bonds to have shorter durations are also those that cause them to be more likely to be called.

The adjusted returns reported in Table 2 show that higher *ex ante* risk, proxied by bond rating, is accompanied by higher *ex post* returns for the investment grade bonds. This research next investigates whether the increased returns are commensurate with the increased risk.

Five return models are estimated for each of the bond portfolios. The five models used are the (single factor) market model used by Blume and Keim (1987) with a stock market index; a duration-adjusted market model corresponding to equation (2) with Ibbotson-Dimson betas computed with two month lagging data; a two factor market model (similar to one used by Blume, Keim, and Patel (1991)) in which interest rate factors are added to the single stock market factor; the two factor market model with Ibbotson-Dimson betas (similar to one used by Cornell and Green (1991)); and a residual-based market model corresponding to equation (5) that purges the realized returns for interest rate sensitivity before estimating stock market sensitivity. Because the fifth model most closely reflects the underlying sensitivities to interest rate and stock market factors, it is expected to provide better estimates of the true parameters.

Table 3 contains the estimated systematic risk (i.e., sensitivity to a stock market factor) for each of these five return models. The first column reports the results of estimating the single factor market model. The results are similar to those reported in Blume and Keim (1987) for their junk bond study—the estimated betas are similar for Aaa bonds and junk bonds. The other four returns models, which include some adjustment for interest rate risk, however, show markedly lower beta estimates for investment grade bonds. In particular, adjusting for interest rate sensitivity using either the duration-adjusted market model (column 2) or the first two factor market model (column 3) produces estimates of beta for the top grade bonds approximately half those of the simple market model. The last two models (columns 4 and 5) that incorporate the Ibbotson-Dimson aggregation technique for the interest rate variables result in economically insignificant estimates of stock market beta as suggested by the underlying theory. The differences in estimated betas between the first and last columns of Table 3 indicate that the highest grade bonds, Aaa and Aa, are affected primarily by interest rate movements rather than stock market movements, while the junk bonds have small interest rate sensitivity. The A and Baa bonds are sensitive to both interest rate and stock market factors.[11]

Table 3 also reveals that the intercepts for the various bond rating classes, α_i, are statistically indistinguishable in the properly specified residual-based market model. They vary in the two factor market model cases because of the multicollinearity between the interest rate and stock market factors which is purged in the residual-based market model.[12] On the other hand, the β_i, which measures stock market sensitivity, does vary across rating classes.

The table supports two important conclusions. First, the estimation of bond systematic risk (as in Blume, Keim, and Patel (1991) and Cornell and Green (1991)) dramatically overstates the actual sensitivity of investment grade bonds to stock market factors after controlling for the sensitivity to interest rate changes. The correlation between stock market returns and bond returns means that there is an omitted variable bias in computing β when interest rate changes are not considered.[13] Second, there is no statistically significant difference

[11]The results of the first pass regression, which generated the residuals used in the second pass for the residual-based market model, show the Aaa and Aa bond returns to be significantly related to the T-bond returns, R_{Tt}; the A bond returns related to both the interest rate factor and T-bond returns; and the Baa bonds related to the interest rate factor, $dI_t/(1+I_t)$. The B grade bonds are not significantly related to interest rate effects.

[12]The highest α belongs to the A rated bonds.

[13]Blume and Keim (1987) report a beta of .37 for investment grade bonds and .30 for lower grade bonds over the 1982-1986 time period. We used their (Blume and Keim) data to compute a

among realized bond returns of varying ratings after the various systematic components of return are controlled in three of the five returns models. Thus, the market for corporate bonds of ratings Aaa through B appears to have been efficient in the 1981-1988 time period.

Comparison of Results with Previous Studies

The results reported here should be contrasted with earlier studies of junk bonds that show substantially higher performance for junk bonds. Some studies are flawed, as they examine the promised yield to maturity versus risk relationship rather than realized holding period return versus risk. It must be noted that a default will cause the rate of return to fall for two reasons. First, the realized cash flows will be lower. Second, the price will drop because expectations of future cash flows are adjusted downward. The lower price, however, will result in an increased yield to maturity. Thus, the poorer the actual performance of the bonds, the better the promised future performance!

The precedent of evaluating bond performance in terms of yield to maturity began with Hickman (1958) who assumed investors were risk-neutral, possibly because no model existed in his day for computing a risk-return tradeoff. Hickman computed a loss rate as the difference between the promised return (yield to maturity) and the realized return. This tradition is inverted today, as many analysts compute the realized return as the difference of the yield to maturity and the loss rate. The loss rate typically is computed as the sum of one coupon payment plus the average capital loss realized from the time of issue to the date of default, all expressed as a percentage of par value. Such computations may be appropriate for an accountant with a financial institution that does not normally sell bonds that are under water, but they are inappropriate as estimates of the actual economic losses to the bondholder. Risk-averse investors will demand a promised return that exceeds the sum of the expected risk free return plus the expected loss rate from default. To the extent that default risk is correlated with the market and interest rate factors, it should be priced. Junk bond returns exhibit sensitivity to both interest rate and stock market risks in this study.

Fons (1987) also uses a risk-neutral framework with early versions of Blume and Keim's (1987) junk bond data. He notes that the spread in promised yields between high and low grade bonds does not solely reflect default probabili-

beta of .33 using their methodology (the market model) which is comparable to our estimate of .30 using our data; furthermore, when we use their data in our methodology (the Ibbotson-Dimson beta from equation (5)), we compute a beta of .106 which is substantially smaller than the .30 computed using their methodology. Thus, our results are not due to our data differing substantially from their data, but due to methodological differences which is the underlying theme of the paper.

ties under variable interest rate regimes. Fons concludes that the realized default rate has little impact on realized returns for junk bonds. Because he controls for neither interest rate changes nor stock market movements, he concludes that low rated bonds realize holding period gains relative to high grade bonds. In contrast, the current research finds no significant difference in risk-adjusted returns among the various grades of bonds after controlling for these factors.

The results are not directly comparable with Altman's (1989) simulation study. Actual monthly holding period returns are analyzed and computed for individual bonds in the current research. Altman examines the return spread for junk bonds and other corporate bonds over Treasury bonds over the period 1971-1987.[14] Capital gains or losses are not imputed for bonds not defaulting. Although precise details are not given by Altman, apparently the return spread plus the YTM of a (par) Treasury issue is used each period to impute returns to the junk bonds which are compounded. The returns computed by Altman are difficult to interpret and probably are affected by the varying interest rate levels over the period of his study. In any case, his results should be recognized as coming from a simulation study attempting to capture typical spreads, rather from actual returns from real bonds as used in the present study.

Although Asquith *et al.* did not directly address the risk-return tradeoff, their conclusions are in concert with these findings. In particular, the default experience must be combined with the call experience as well as any capital gains or losses arising from interest rate changes before conclusions can be drawn about the relative performance of junk bonds.

As noted in the previous section, this research finds that investment grade bonds have little or no sensitivity to stock market effects when interest rate sensitivity first is purged from bond returns. This finding is in sharp contrast to the recent works of Blume, Keim, and Patel (1991) and Cornell and Green (1991) who make no such adjustment. Using improved methodology, however, this research is able to confirm their general finding that junk bonds seem to have been priced properly.

Summary

This paper has used modern finance techniques to reexamine the investment performance of junk bonds. Unlike early efforts, this study examines the risk-return tradeoff implicit in investments by explicitly controlling for interest rate and stock market risks. In addition, this study corrects for methodological errors

[14] Altman appears to compute return spread as the actual yield to maturity spread at birth minus the realized loss. The realized loss is computed as the capital loss after default plus the loss of one coupon payment. Altman, like Blume and Keim, removes defaulting bonds from further consideration.

in the recent (1991) junk bond studies. The findings resulting from the analysis are substantially different from those of all earlier studies that examine the same time period.

These different findings occur because of a number of significant extensions this work makes on previous efforts. For example, Asquith *et al.* (1989, pp. 943-944) call for transactions-based return data and a complete or random sample of high yield bonds. In their view, this remains an important topic for future research. This research has examined all industrial, nonconvertible bonds issued from 1976 to 1980 and initially rated B or better by Moody's with exchange-based prices. Asquith *et al.* (p. 925) suggest measuring default risk within a cohort of bonds issued at the same time. The same reasoning supports using such a cohort when examining returns. Including recently issued bonds means that the index will not be representative of the investment performance of seasoned bonds. This is exacerbated by the correlation of call, default, and exchange probabilities with the amount of time elapsed since issuance. Asquith *et al.* (p. 925) note the two major deficiencies of previous studies of default risk are failure to consider exchanges and aging of bonds. This research solves the aging problem with a limited time cohort that is still comprehensive—it includes all industrial nonconvertible bonds issued and rated in the period 1976-1980. The exchange problem is solved by following CRSP's procedure in valuing exchanges at the market value of securities received and then reinvesting the proceeds in the same portfolio.

The results presented in this paper lead to two major conclusions. First, contrary to earlier studies, bonds with lower ratings do not produce significantly higher returns (after adjusting bond returns for interest rate sensitivity) during the period 1981-1988. Thus, bond ratings do not serve as a predictor of higher or lower realized return. Although bond ratings may convey the relative default probability accurately, the expected returns do not appear to be affected by the default probability. The ratings, however, are correlated strongly with promised yield to maturity. This is in sharp contrast to the case of S&P stock quality rankings, which Muller and Fielitz (1987) have shown are reliable proxies for risk and expected return. Those investors who value results more highly than promises will need more information than the bond rating and promised yield to maturity.

Second, the systematic risk (beta) of top grade (Aaa and Aa) bonds is indistinguishable from zero after allowance has been made for economy-wide changes in interest rates. That is, the nonzero betas reported by Blume and Keim (1987), Blume, Keim, and Patel (1991), and Cornell and Green (1991) over similar time spans are due to the joint impact of interest rate changes on bonds and stocks. After purging the impact of these interest rate changes from the bond portfolios, the stock market-related risk of quality corporate bonds is negligible. Junk bonds have relatively minor interest rate risks when compared with their stock market related risks.

The results presented in this paper are consistent with the corporate bond market being efficiently priced from 1981 to 1988. Although recent evidence on junk bonds reported in the popular press may suggest otherwise, junk bonds have neither superior nor inferior risk-adjusted performance within the time period of this study which spans the boom and bust cycle of junk bonds.

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Table 1
Portfolio Realized Returns and Yields to Maturity

Moody's Rating	Number Bonds	Monthly Average Return	Monthly Standard Deviation	Annualized Average Return	Annualized Average YTM
T-Bond		1.187	3.971	14.18	10.65
Aaa	29	1.274	2.708	15.91	11.26
Aa	48	1.342	2.398	16.96	11.92
A	95	1.348	1.787	17.21	12.30
Baa	25	1.425	1.813	18.28	13.02
Ba *	12	1.330	2.183	16.86	14.29
B	67	1.334	2.756	16.73	19.62
Average	276	1.339	1.938	17.05	13.67

Average holding period returns from investing in bonds with ratings shown from 1981 to 1988. Standard deviation is the standard deviation of these monthly returns about the mean. Both monthly average returns and standard deviations are in percent per month. Average yield to maturity is expressed in percent per year. Number of bonds reflects the number of bonds in each rating as of January 1981

*No further analysis was performed on these bonds because of the small portfolio size

Table 2
Portfolio Adjusted Returns = R — C_{Tbond} + $D_s dI/(1+I)$

Moody's Rating	Adjusted Return	Standard Deviation
Aaa	.198	2.559
Aa	.295	2.816
A	.320	2.876
Baa	.419	3.279
B	.333	3.228
Average	.313	2.714

Average adjusted returns are average monthly holding period returns from investing in bonds with ratings shown from 1981 to 1988, adjusted for interest rate changes and coupon income on a risk free bond. Standard deviation is the standard deviation of these monthly returns about the mean. All numbers are in percent per month

Table 3
Estimates of β Using a Variety of Returns Models

	Market Model	Duration-Adjusted Market Model	Two Factor Market Model (1)	Two Factor Market Model (2)	Residual-Based Market Model
Aaa	.2830 (5.633)**	.1239 (1.373)	.1282 (3.292)**	.0301 (.634)	.0186 (.425)
Aa	.2374 (5.248)**	.1548 (1.569)	.1240 (3.292)**	.0612 (1.255)	.0477 (1.062)
A	.1806 (5.392)**	.1873 (1.898)	.1137 (3.630)**	.0893 (2.633)**	.0731 (2.313)*
Baa	.2013 (6.121)**	.2494 (2.215)*	.1892 (5.298)**	.2018 (3.987)**	.1638 (3.423)**
B	.3104 (6.312)**	.2963 (2.674)**	.2748 (5.267)**	.3225 (3.686)**	.2452 (3.061)**
χ^2					
$\alpha_1 = \alpha_n$	2.064	.5740	11.150*	9.987*	2.115
χ^2 $\beta_1 = \beta_n$	20.075**	5.902	16.471**	17.758**	19.215**

Market Model: $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$

Duration-Adjusted Market Model: $R_{it} - C_{Tt} + D_{it}[dI_t/(1+I_t)] = \alpha_i + \Sigma\beta_i R_{mt} + \varepsilon_{it}$

Two Factor Market Model (1): $R_{it} = \alpha_i + \beta_i R_{mt} + \delta_i[dI_t/(1+I_t)] + \Theta_i R_{Tt} + \varepsilon_{it}$

Two Factor Market Model (2): $R_{it} = \alpha_i + \Sigma\beta_i R_{mt} + \Sigma\delta_i[dI_t/(1+I_t)] + \Sigma\Theta_i R_{Tt} + \varepsilon_{it}$

Residual-Based Market Model: $R_{it} - \Sigma\delta_i[dI_t/(1+I_t)] - \Sigma\Theta_i R_{Tt} = \alpha_i + \Sigma\beta_i R_{mt} + \varepsilon_{it}$

Σ signifies includes contemporaneous and two lagging observations; reported β in table is the sum of the three coefficients of the R_{mt} variables

Numbers in parentheses are t-statistics

* Denotes significant at 95 percent level
** Denotes significant at 99 percent level