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Returns and Volatility of Low-Grade Bonds 1977-1989

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ABSTRACT

This paper examines the risks and returns of long-term low-grade bonds for the period 1977-1989. We find: (1) low-grade bonds realized higher returns than higher-grade bonds and lower returns than common stocks, and low-grade bonds exhibited less volatility than higher-grade bonds due to their call features and high coupons; (2) there is no relation between the age of low-grade bonds and their realized returns; cyclical factors explain much of the observed relation between default rates and bond age; and (3) low-grade bonds behave like both bonds and stocks. Despite this complexity there is no evidence that low-grade bonds are systematically over- or under-priced.

ONE OF THE MOST significant financial innovations in recent years has been the development of a public market for less-than-investment-grade debt. Prior to 1977 virtually all publicly traded bonds at the time of issue carried an investment-grade rating. Of course, some of these bonds became "fallen angels" as their credit quality deteriorated, and some did default. Beginning in 1977 investment banking firms began to issue bonds with credit quality below investment grade. The growth in the market has been dramatic; according to Drexel Burnham Lambert, new issues of low-grade bonds increased from $1.1 billion in 1977 to $24.2 billion in 1989. Drexel estimates that at the end of 1989 the outstanding market value of low-grade bonds was $205 billion, representing roughly one-quarter of the total corporate debt market. Less than a quarter of the outstanding value of low-grade bonds represents "fallen angels."

Given the size of this market, we know surprisingly little about the returns and risks of investing in it. Considerable research exits on the relation

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between original bond quality ratings and the incidence of default.[1] Such studies are of obvious interest to bondholders, but of more fundamental interest are the returns that these bonds actually realize.

A major hindrance to the analysis of the returns of low-grade bonds has been the difficulty of obtaining reliable prices for calculating realized returns.[2] As an example, a price from the *Bank and Quotation Record*, a source used in some prior studies, may be a transaction price, an average of bid and ask prices, or either a bid or an ask price.[3] The returns computed from this source involve combinations of any four of these possible prices. Statistically, the use of this mixture of prices results in an upward bias in the calculated returns, and the bias increases as the bid-ask spread widens.[4] To remedy these problems, Blume and Keim (1987) assembled an extensive data base of dealer bid prices supplied by traders at Drexel Burnham Lambert and at Salomon Brothers.

The first section of this paper uses the Blume and Keim data, updated through 1989, to estimate summary statistics of the distribution of historical returns for low-grade bonds and to compare the returns of low-grade bonds with the returns of other classes of assets.[5] The other classes are long-term Treasury bonds, long-term high-grade corporate bonds, the S&P 500, and small capitalization stocks.

The relative ranking of the realized returns of low-grade bonds varies from one time period to another. For the longest period studied, 1977–1989, the realized returns of these bonds are greater than those of long-term governments and long-term high-grade corporates but less than those of the S&P 500 or small stocks. Unlike the realized returns, the relative ranking of the variance of the returns for low-grade bonds is stable over time and is always less than the variance for any of the other asset classes. The lower variance of low-grade bonds, relative to long-term Treasuries and high-grade corpo-

[1] Hickman (1958), Fraine and Mills (1961), and Atkinson (1967) are examples of early studies of the relation of original quality ratings and defaults. Altman (1987, 1989) and Asquith, Mullins and Wolf (1989) have extended these types of studies to the low-grade bond market as it has developed since 1977.

[2] See Nunn, Hill, and Schneeweis (1986) for a discussion of the potential problems in using published prices to measure bond returns. Some researchers (e.g., Altman (1989) and Goodman (1990)) have attempted to simulate the returns for a diversified investment in low-grade bonds. These simulations rely on assumptions about such critical variables as: coupon spreads between low-grade and Treasury bonds; the path of interest rates over the simulation period (most often assumed to be constant); the temporal profile of defaults, calls, and other events that affect the age, maturity, and composition of the index; the percent of par value of the bond recovered at liquidating events such as defaults and exchanges; and reinvestment rates. In addition to the imprecision arising from such assumptions, these simulations suffer foremost from lack of actual prices for the bonds being studied.

[3] For example, Weinstein (1983, 1987) and Chang and Pinnegar (1986).

[4] See Blume and Stambaugh (1983) for a discussion of such a bias in the context of stock returns.

[5] Cornell and Green (1990) use returns for low-grade bond (open end) mutual funds to estimate the risks and returns of low-grade bonds. Their results are comparable with those reported below.

rates, stems from the shorter duration of low-grade bonds due to their larger coupons and greater probability of early call.

There is a possible caveat in interpreting these results as representative of the universe of low-grade bonds. The market for low-grade bonds is young and has experienced rapid growth, resulting in a heavier concentration of the market in recently issued bonds than would be the case if the market were more mature. If the probability of default increases or, more importantly, return characteristics change with the age of a bond, overall sample statistics from our data may be misleading if the original buyers of the bonds did not properly anticipate these risks.[6] To determine the importance of this caveat, the study examines the relation between the age of low-grade bonds and their default rates and returns. Importantly, there is no observable relation between age and returns, and cyclical factors explain a large portion of the previously observed relation between age and default rates.

The second section of this paper contains an analysis of the covariability of low-grade bond returns with returns on other assets. Some have described low-grade bonds as hybrid securities; they have the appearance of fixed-income obligations but without an equity cushion. An examination of the separate influences of unexpected changes in interest rates, equity returns, and seasonal effects on low-grade bond returns supports this conjecture.

The third section addresses the issue of the efficiency of the low-grade bond market and finds no evidence that low-grade bonds are systematically mispriced.

The fourth section presents a brief summary of the main empirical results.

I. Characteristics of Low-Grade Bond Returns

The summary statistics for low-grade bonds in this section are based on three different sources. The primary source is a data base of low-grade prices covering the years 1982-1988. These prices are month-end bid prices from Drexel Burnham Lambert and Salomon Brothers.[7] The specific bonds included in the analysis satisfy the following criteria: (1) face value at time of

[6] Altman (1989) and Asquith, Mullins and Wolff (1989) discuss the relation between default rates and age of low-grade bonds.

[7] See Blume and Keim (1987) for a detailed description of the construction of this data base, which at the time covered the years 1982-1986. In that article, they find that there are sometimes significant differences in the prices of individual bonds from Drexel and Salomon, but the differences between the prices tend to offset other in an index. Thus, the index is more reliable than the prices of individual bonds.

Until recently Drexel and Salomon stopped reporting the month-end bid prices in the month before a bond defaulted, something that could only be done with hindsight. Moreover, they sometimes retroactively dropped a bond for other reasons. To avoid this hindsight bias, the Drexel and Salomon data are augmented with total returns derived from prices in the *S&P Bond Guide* for the two months **following the deletion** of a bond from either the Drexel or Salomon sample unless it was called or exchanged. Subsequent to the 1987 study, Salomon and Drexel adopted similar procedures to avoid hindsight bias, and following these changes, we stopped augmenting their bond prices.

Table I

Summary Statistics of Returns for Various Asset Categories

These statistics are based upon several indexes of monthly returns. From 1977 through 1988, the bonds underlying the low-grade bond index are all nonconvertible with face value at time of issue of greater than \$25 million and with time to maturity of at least 10 years from the date on which any return is calculated. The returns for the individual bonds from 1982 through 1988 are based upon bid prices from Drexel Burnham Lambert and Salomon Brothers and prior to 1982 upon prices from the *S&P Bond Guide*. The return indices from 1977 through 1988 are averages of these returns by month. For 1989 Drexel calculated a monthly return index using bid prices in virtually the same way as the 1977–1988 indices were calculated, and this index was used to extend the sample through 1989. The returns for (1) the S&P 500, (2) a value-weighted portfolio of common stocks in the smallest size quintile on the NYSE, (3) the Salomon Brothers index of long-term high-grade (rated A and above) corporate bonds, and (4) long-term (approximately 20 years to maturity) government bonds are from Ibbotson Associates.

	Annual	Monthly		Adjusted Standard Deviation*		Autocorrelation		
	Geometric Mean	Mean Return	Standard Deviation	1st Order	1st&2nd Order	ρ_1	ρ_2	ρ_3
A. 1/1977 to 12/1989								
Long-term government bonds	9.3%	0.81%	3.76%	3.97%	3.91%	0.07	−0.02	−0.14
High-grade bonds	9.7	0.83	3.46	3.91	3.85	0.15	−0.02	−0.10
Low-grade bonds	10.2	0.85	2.70	3.15	3.05	0.20	−0.05	−0.12
S&P 500	14.6	1.25	4.56	4.69	4.31	0.03	−0.10	−0.08
Small stocks	19.1	1.65	5.88	6.46	6.19	0.11	−0.06	−0.13
B. 1/1977 to 12/1988								
Long-term government bonds	8.6	0.76	3.85	4.06	4.03	0.06	−0.01	−0.14
High-grade bonds	9.1	0.79	3.56	3.99	3.96	0.14	−0.01	−0.01
Low-grade bonds	11.3	0.93	2.74	3.16	3.04	0.18	−0.06	−0.13
S&P 500	13.3	1.16	4.63	4.80	4.45	0.04	−0.09	−0.09
Small stocks	19.4	1.68	5.97	6.59	6.22	0.12	−0.08	−0.13

issue is greater than \$25 million; (2) the bonds are not convertible; and (3) time to maturity is at least 10 years from the date on which a return is calculated. As of December 1988, the average maturity of our sample is 14.7 years.[8]

To provide a longer perspective, we augmented our basis data with additional data prior to 1982 and after 1988. Prior to 1982 we collected month-end prices for the 1977–81 period for **all** bonds rated below BBB listed in the

[8] Recently-issued low-grade bonds tend to have shorter maturities than those issued in the earlier years of this market. For example, Drexel (1989a) estimated that 59 percent of the straight low-grade debt issued in 1988 had a maturity less than 10 years and that 57 percent of the straight low-grade debt outstanding at the end of 1988 had a maturity less than 10 years. Because of our requirement of a maturity greater than 10 years, our sample of low-grade bonds may not be representative of the overall market, and our average maturity of 14.7 years undoubtedly overstates the maturity for the market as a whole. Retaining this requirement preserves a degree of comparability with other long-term bond indexes.

Table I—*Continued*

	Annual	Monthly		Adjusted Standard Deviation*		Autocorrelation		
C. 1/1982 to 12/1989								
Long-term government bonds	16.3	1.32	3.40	3.55	3.66	0.05	0.04	−0.07
High-grade bonds	17.1	1.36	2.98	3.33	3.49	0.13	0.08	−0.04
Low-grade bonds	14.0	1.13	2.24	2.79	2.99	0.31	0.13	0.06
S&P 500	18.9	1.57	4.77	4.93	4.76	0.04	−0.05	−0.09
Small stocks	13.4	1.20	5.21	6.11	6.11	0.21	−0.00	−0.07
D. 1/1982 to 12/1985								
Long-term government bonds	20.9	1.65	3.37	3.61	4.01	0.08	0.16	−0.16
High-grade bonds	23.1	1.80	3.47	3.85	4.12	0.13	0.11	−0.07
Low-grade bonds	20.9	1.62	2.37	2.99	3.18	0.33	0.12	0.11
S&P 500	20.2	1.62	4.03	4.09	4.50	0.02	0.13	−0.16
Small stocks	20.1	1.64	4.59	5.48	5.92	0.23	0.14	0.01
E. 1/1986 to 12/1989								
Long-term government bonds	11.9	1.00	3.44	3.49	3.01	0.02	−0.16	−0.10
High-grade bonds	11.4	0.93	2.36	2.56	2.33	0.10	−0.12	−0.13
Low-grade bonds	7.5	0.63	2.00	2.33	2.35	0.19	0.01	−0.15
S&P 500	17.6	1.52	5.45	5.71	5.01	0.05	−0.15	−0.09
Small stocks	7.0	0.75	5.78	6.66	6.14	0.18	−0.12	−0.16

* Stale prices can induce positive but spurious autocorrelation in the indices of returns, biasing downward the estimated standard deviation of monthly returns. To examine the magnitude of this bias, the monthly standard deviations were adjusted in a two-step procedure: First, annualize the estimated monthly standard deviation, taking into account the autocorrelation. If σ^2 is the monthly variance and the first order autocorrelation is ρ_1 with all other autocorrelations zero, the variance of the sum of 12 monthly returns is σ^2 $(12 + 22\ \rho_1)$. Thus, multiplying the monthly standard deviation by $(12 + 22\ \rho_1)^{1/2}$ yields an annual standard deviation that takes into account the first order serial correlation. Second, divide by the $\sqrt{12}$ to reexpress this annual standard deviation in monthly units. If the second order autocorrelation is ρ_2 and all high order autocorrelations are zero, the multiplying constant is $(12 + 22\ \rho_1 + 20\ \rho_2)^{1/2}$.

S&P Bond Guide satisfying the same three conditions as the 1982-88 sample. Although these data may not be as reliable as the Drexel and Salomon data, they do extend the sample back to 1977—the beginning of the modern low-grade bond market.[9] Despite the potential problems with the earlier data, the inferences from both sets of data are similar. For 1989 the monthly index returns are the returns of a long-term index developed by Drexel. Drexel (1989b) adopted virtually the same criteria that we imposed

[9] A price from the *S&P Bond Guide* represents the closing price on the New York Bond Exchange or, if not available, the average bid price from one or more market makers or, if neither is available, a "matrix" price. As a consequence, and as mentioned above, monthly returns calculated from this source may be upward biased. To examine the extent of this bias, Blume and Keim (1987) collected prices from the *S&P Bond Guide* for the same bonds in the primary sample for this study for the 1982-1986 period. The correlation between the indices constructed from these two data sources is 0.92. In view of this high correlation, the text reports some results going back to 1977.

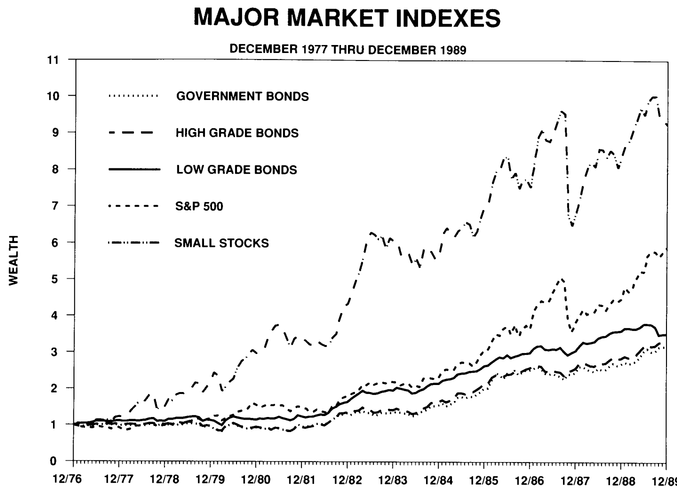


Figure 1. Major Market Indexes from December 1976 through December 1989. These indices are all scaled to be 1.0 on December 1976 and are taken from various sources. From 1977 through 1988 the bonds underlying the low-grade bond index are all nonconvertible with face value at time of issue of greater than $25 million and with time to maturity of at least 10 years from the date on which a return is calculated. The returns of individual low-grade bonds from 1982 through 1988 are based upon bid prices from Drexel Burnham Lambert and Salomon Brothers and prior to 1982 upon prices from the *S&P Bond Guide*. The return indices from 1977 through 1988 are averages of these returns by month. For 1989 Drexel calculated a monthly return index in virtually the same way as the 1977-1988 indices were calculated, and this index was to extend the sample through 1989. The returns for (1) the S&P 500, (2) a value-weighted portfolio of common stocks in the smallest size quintile on the NYSE, (3) the Salomon Brothers index of long-term high-grade (rated A and above) corporate bonds, and (4) long-term (approximately 20 years to maturity) government bonds are from Ibbotson Associates. Linking these returns together yield the plotted index values.

for the 1982-88 data in the construction of this index, and the Drexel index is thus comparable to the pre-1989 indices.[10] (The appendix contains the monthly returns of this index.)

For comparison, we also report results below for several stock and bond indices as published by Ibbotson Associates. The stock market indices are the S&P 500 and a value-weighted portfolio of stocks in the smallest quintile of NYSE common stocks. The long-term high-grade corporate bond index is identical to the Salomon Brothers index of the same name. The long-term government bond index has a maturity of roughly 20 years and is derived by Ibbotson Associates from data in the *Wall Street Journal*.

A. Realized Returns

From 1977 through 1989, low-grade bonds realized a compounded annual rate of return of 10.2 percent (Table I and Figure 1). During these years,

[10] The only major difference is that Drexel does not require that the issue size be equal to or greater than $25 million. Since the average issue size has grown over time, this difference is not likely to be substantial in 1989.

low-grade bonds realized greater returns than long-term Treasury bonds (9.3 percent) and long-term high-grade corporate bonds (9.7 percent), but lower returns than the S&P 500 (14.6 percent) and an index of small stocks (19.1 percent).[11]

From 1982 through 1989, the period for which we have Drexel and Salomon dealer bid prices and the new Drexel index, low-grade bonds realized a compounded annual rate of return of 14.0 percent. During these more recent years, low grade bonds realized lower returns than the Treasury bonds (16.3 percent), long-term high-grade corporate bonds (17.1 percent), and the S&P 500 (18.9 percent) but did realize greater returns than small stocks (13.4 percent). In either half of the 1982–89 period, the realized returns on low-grade bonds are never the greatest nor the least. In both halves the returns on low-grade bonds exceed those of small stocks. The average monthly returns lead to the same conclusions.[12]

The popular press in 1989 contained many reports describing the turbulence in the market for low-grade bonds. The dominant underwriter and market maker Drexel Burnham Lambert was in serious financial trouble and would ultimately declare bankruptcy. Savings and loan associations were dumping their large holdings of low-grade bonds. The returns realized by low-grade bonds are consistent with these reports of turbulence. During 1989, low-grade bonds realized a loss of −2.2 percent, while some other types of assets realized substantial positive returns.[13] Of the other four asset groups in Table I the S&P 500 realized the greatest return of 31.5 percent and small stocks the lowest return of 10.2 percent. If one excludes the 1989 returns and examines the shorter 1977–1988 period, the relative rankings of the realized returns of these asset groups remains unchanged (Table I). The gap between low-grade bonds and the higher grade bonds widens, but equities still have the greatest returns.

[11] Cornell and Green (1990) report an average monthly return of 0.77 percent for their index of low-grade bond funds over the same 1977–1989 period. This is lower than our average monthly return of 0.85 percent because: (1) their return is reported net of management fees; (2) the funds in their index hold cash reserves which will tend to dampen the average returns during periods like the 1980's when low-grade bonds achieved higher returns than money market instruments; and (3) it is likely that our sample of long-term low-grade bonds has a longer average maturity (and duration) than the bonds contained in the managed funds in their index. As a result, the average return for their index of low-grade funds is lower than the long-term high-grade corporate and Treasury bonds for this period.

[12] Since the low-grade bond prices for 1982–1988 are bid prices, there should be no bid-ask bias in the equally-weighted index of low-grade bonds reported in the text. The logic of Blume and Stambaugh (1983) implies that an index representing the return from holding a single bond of each issue virtually eliminates the bid-ask bias. The estimate of the returns on this latter index is the ratio of the sum of the bond prices at the end of one month to the sum of the bond prices for the same bonds at the end of the prior month, all adjusted for accrued income and coupon payments. The average monthly return on this alternative index for 1982–1988 is 1.33 percent, and the annual geometric mean is 16.8 percent. These estimates compare to 1.31 percent and 16.6 percent for the 1982–1988 period for the low-grade bond index discussed in the text, respectively. That these two methods of constructing indices lead to virtually the same numbers implies the absence of any bid-ask bias, as should happen if the bond prices are really bid prices.

[13] In their December release, Drexel Burnham Lambert reported an annual loss of 0.95 percent. This number was in error and was corrected in subsequent releases.

B. The Relative Volatility of Low- and High-Grade Bonds

In each of the five periods reported in Table I, the estimated standard deviation of the monthly low-grade bond returns is less than that for any of the other four categories of assets. A visual examination of the frequency distributions of returns for the 1977–1989 period confirms this relative ranking (Figure 2). If one excludes the 1989 returns and examines the 1977–1988 period by itself, low-grade bonds still have the least volatility.

One possible explanation for this perhaps unexpected result is statistical and is related to "stale" prices among the individual bond prices in the index. To illustrate, assume that the prices of all low-grade bonds fall but that dealers mark down only half of the prices the first month and the remaining half the following month. Changes in an index of such prices will spread themselves across both months, inducing positive autocorrelation in the calculated returns for the index and a downward bias in the estimated standard deviations.[14]

The first order autocorrelations for all of the monthly indices of the five different types of assets are positive in each period (Table I) with the greatest values associated with low-grade bonds and small stocks, a finding consistent with stale prices. Even so, after adjusting the estimated standard deviations of monthly returns for the observed autocorrelation, low-grade bonds still display the lowest standard deviation (Table I).[15]

The remainder of this section explores the reasons for the lower volatility of low-grade bonds in comparison to the higher-grade bonds. To do this, consider the possible sources of the variance of the return of any individual low-grade bond. There is no unique way to decompose this variance, but for the purposes of this paper it is useful to identify three sources of variance: factors unique to a specific bond, factors common to low-grade bonds, and changes in the general level of interest rates. In an equally weighted portfolio of a large number of bonds, diversification virtually eliminates bond-specific risk, so the following analysis of low-grade bond indices ignores this type of risk and concentrates on the other two sources of volatility.

The average time to maturity for the low-grade bond index is slightly less than 15 years at the end of 1988, while the average time to maturity for the

[14] Fisher (1966) is perhaps the first to analyze the effect of stale prices on the autocorrelation of returns in an index.

[15] The adjustment process first annualizes the estimated monthly standard deviations, taking into account the autocorrelation, and then reexpresses these annualized standard deviations in monthly units. If σ^2 is the monthly variance and the first order autocorrelation is ρ_1 with all other correlations zero, the variance of the sum of 12 monthly returns is $\sigma^2\ (12 + 22\rho_1)$. Thus, multiplying the monthly standard deviations by $(12 + 22\rho_1)^{1/2}$ yields an annual standard deviation that takes into account the first order serial correlation. Dividing by $\sqrt{12}$ reexpresses this annual standard deviation in the monthly units reported in Table I. If the second order autocorrelation is ρ_2 and all high order autocorrelations are zero, the multiplying constant is

$$(12 + 22\rho_1 + 20\rho_2)^{1/2}.$$

indices of long-term Treasury and long-term high-grade corporate bonds is 20 years. Other things equal, the shorter maturity of low-grade bonds compared with the higher grade bonds indicates that low-grade bonds have a shorter duration and, therefore, will be less sensitive to interest rate movements.[16]

Even if the average time to maturity were the same for low-grade bonds and either high-grade corporate bonds or Treasury bonds, the low-grade bond index will still have a shorter duration and hence less sensitivity to interest rates, for two reasons. First, the coupons on low-grade bonds are greater than those on governments or high-grade corporates. If the current prices and the time to maturity of two bonds are the same, the one with the greater coupon will have a shorter duration. Second, corporate bonds (both low- and high-grade) are often callable after a call protection period of a limited number of years, while governments are noncallable or only callable near maturity.[17,18] If interest rates drop, there is an increased probability that issuers of callable corporate bonds will call them, effectively shortening their duration. In addition, if the credit quality of a low-grade bond issuer improves, it may be attractive to call and refinance the bond with a higher quality bond even if there are no changes in interest rates. This possibility of credit improvement further shortens the duration of low-grade bonds in comparison to both long-term governments and high-grade corporates.

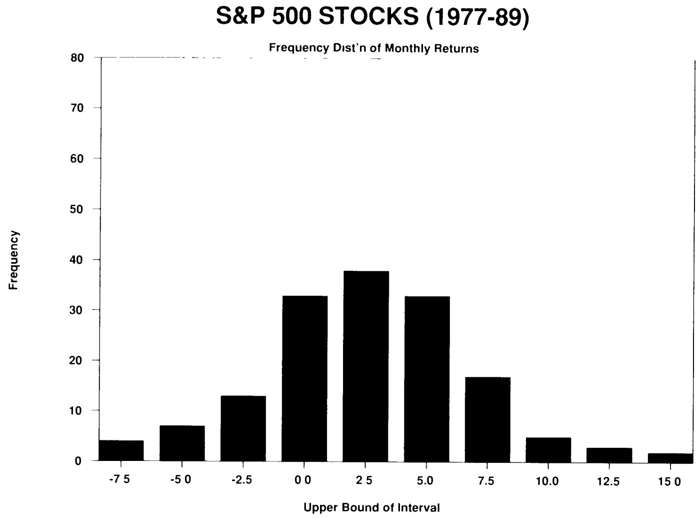
The shorter duration of low-grade bonds reduces relative volatility, but offsetting this reduction is the possibility that additional factors common to all low-grade bonds increase volatility. The spread between the yields on low-grade and long-term government bonds is a measure of these additional factors. That the standard deviation of returns for the low-grade bond index is less than that for the government bond index implies that the reduction in volatility due to shorter duration exceeds the increase in volatility stemming from unexpected changes in spreads.

To separate the volatility of low-grade bonds due to unexpected changes in interest rates from that due to unexpected changes in spreads, we construct an equivalent "default-free bond" for each low-grade bond and form an index of these equivalent bonds. Such an equivalent index mirrors the same call, coupon, and maturity features of the low-grade bond index. Hence, any differences in volatility between our low-grade index and the default-free

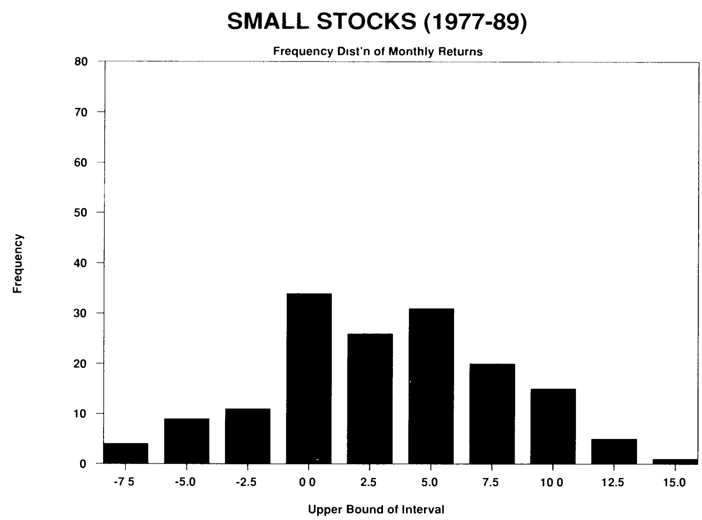
[16] There are many possible mathematical definitions of duration, each making slightly different assumptions about the way in which interest rates move. The text will use the term loosely. One would need to postulate a specific bond pricing model and a stochastic process for interest rates to prove rigorously the statements in the text.

[17] At the end of 1988, the average time to first call for our low-grade bond sample is 3.50, resulting in an average duration measured to first call of 1.99 years.

[18] Some low-grade bonds provide considerably less call protection than high-grade bonds. Some low-grade bonds are callable after only three years, and there are some that are callable immediately. Most high-grade bonds provide a five- or a ten-year call protection period. If the call protection provisions of low-grade bonds are less stringent than high-grade bonds, the call features of low-grade bonds would lead to a relatively greater reduction in volatility than of high-grade bonds.



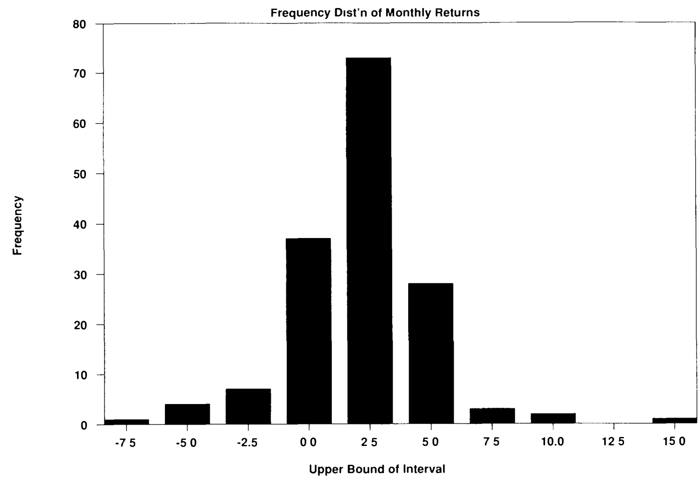
(a)



(b)

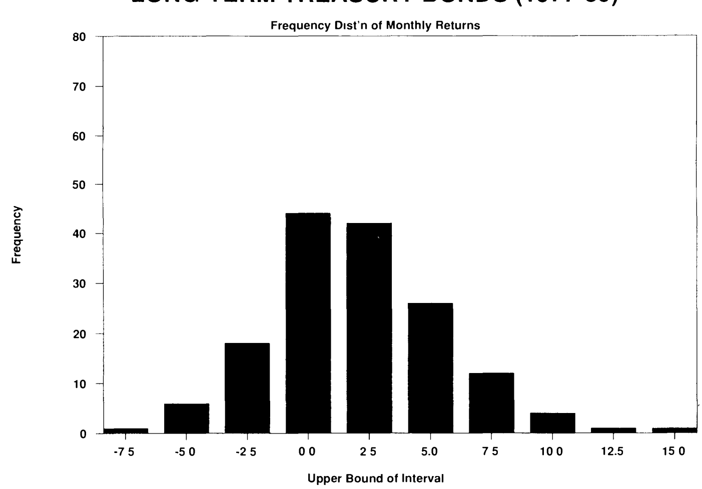
Figure 2. Frequency Distributions of Monthly Returns for Low-Grade Bonds, Long-Term Treasury Bonds, Small Stocks, and the S&P 500. This figure illustrates the lower volatility of low-grade bonds. These histograms are based upon various indexes of monthly returns. From 1977 through 1988, the bonds underlying the low-grade bond index are all nonconvertible with face value at time of issue of greater than $25 million and with time to maturity of at least 10 years from the date on which a return is calculated. The returns of individual low-grade bonds from 1982 through 1988 are based upon bid prices from Drexel Burnham Lambert and Salomon Brothers and prior to 1982 upon prices from the *S&P Bond Guide*. The return indices from 1977 through 1988 are averages of these returns by month. For 1989, Drexel calculated a monthly return index in virtually the same way as the 1977–1988 indices were calculated, and this index was used to extend the sample through 1989. The returns for (a) the S&P 500, (b) a value-weighted portfolio of common stocks in the smallest size quintile on the NYSE, (c) the Salomon Brothers index of long-term high-grade (rated A and above) corporate bonds, and (d) long-term (approximately 20 years to maturity) government bonds are from Ibbotson Associates.

LOW-GRADE (JUNK) BONDS (1977-89)



(c)

LONG-TERM TREASURY BONDS (1977-89)



(d)

Figure 2. Continued

equivalent portfolio can be attributed to volatility stemming from unexpected changes in spreads.

Our construction of an equivalent "default-free" bond involves two steps. First, identify a portfolio of government bonds that matches the promised cash flows from the coupons and principal repayment for each low-grade bond at the time it first enters the sample.[19] Then, estimate the value of the call provision of the low-grade bond and subtract this estimate from the price determined in the first step.[20] The returns from this adjusted series of prices mimic an equivalent callable default-free bond. Averaging these returns over all bonds in a specific month provides an equivalent monthly index.

The returns of this equivalent index, constructed of the "default-free" bonds having the same call and coupon features as the low-grade bonds, are less volatile than the returns of the low-grade bond index itself. The standard deviation of the index of equivalent default-free callable bonds is 1.93 percent, while the standard deviation of the low-grade bond index over the same period is 2.21 percent (Figure 3). Thus, the low standard deviation of low-grade bonds in comparison to governments is due to the coupon levels of these bonds and their call features.

The call features of low-grade bonds are critical in explaining the low volatility of these low-grade bonds. If one adjusts the governments only for coupon level *but not* for call features, the standard deviation of an index of such default-free bonds is 3.05 percent (Figure 3). Thus, adjusting only for differences in coupons does not reduce the volatility of governments to a level below that of the low-grade bonds. The further adjustment for call features is necessary to reduce the volatility of governments to a level below that of low-grade bonds.

In sum, the volatility of the low-grade bond index is less than indexes for

[19] We use a backward iterative algorithm to match the cash flows of the low-grade bond with the cash flows of a portfolio of government bonds. First, identify a government bond that matures at the same time as the low-grade bond. Second, determine the number of government bonds to buy in order to match the cash flow at maturity of the low-grade bond. Third, reduce all the previous payments on the low-grade bond by the coupon payments on the government bond. We repeat these three steps, but with the "maturity" redefined as the date of the last uncovered cash flow until we identify a portfolio of the government bonds that mimics the cash flows of the low-grade bond. In the first step, if we cannot identify a government bond that matures at the same time as the low-grade bond, we identify a government bond that matures before the low-grade bond. We then assume that the payments on the government bond are reinvested at the coupon rate on the government bond.

[20] The Black-Scholes formula is used to estimate the value of the call provision on a bond. This estimate values the call provision up to the end of the call protection period only and thus implicitly assigns a zero value to the call after the call protection period. Explicitly valuing this additional call protection would only lead to a further reduction in the volatility of the comparable default-free bonds. The risk-free rate used in this calculation is the 6-month Treasury Rate provided by Salomon Brothers. Also, the Black-Scholes formula does not take into account the possibility of early call due to an improvement in credit rating. Again, if it were possible to evaluate this reason for early call, there would be an even greater reduction in the volatility of the comparable default-free index.

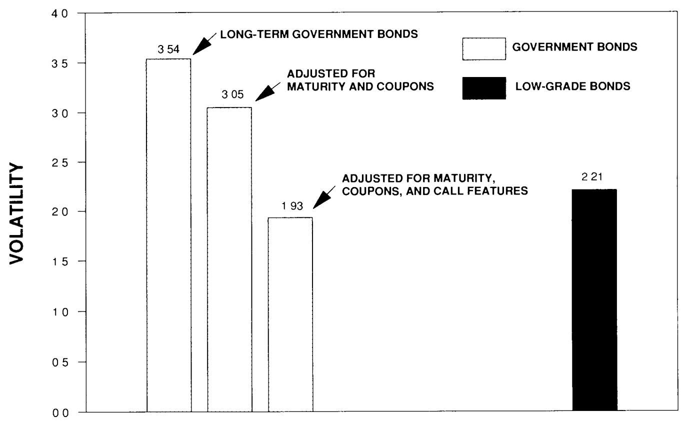


Figure 3. Relative Return Volatility of Low-Grade Bonds Compared to Long-Term Governments and Governments Adjusted for Specific Features of Long-Term Low-Grade Bonds for January 1982 through December 1988. This figure shows that the high coupons of low-grade bonds and their call features account for the lower volatility of low-grade bonds in comparison to long-term government bonds. For these years, the standard deviation of monthly returns for the low-grade bond index used in this paper is 2.21 percent. The standard deviation for the Ibbotson returns for long-term government bonds is 3.54. Adjusted for the actual coupons and maturity of the bonds in the low-grade index, the standard deviation drops to 3.05 percent. Adjusted further for the actual call features of the bonds in the low-grade index, the standard deviation drops to 1.93 percent—a lower standard deviation than the low-grade index. The text describes the specific procedures used in making these adjustments. The bonds underlying the low-grade bond index are all nonconvertible with face value at time of issue of greater than $25 million and with time to maturity of at least 10 years from the date on which a return is calculated. The returns of individual low-grade bonds themselves are based upon bid prices from Drexel Burnham Lambert and Salomon Brothers. The return indexes are averages of these returns by month.

long-term governments, long-term high-grade corporates, the S&P 500, and small stocks. The reasons for this lower volatility are the greater coupons and the call features of low-grade bonds that reduce the duration of these bonds. A government index properly adjusted for these greater coupons and call features is less volatile than the low-grade bond index. The difference between the volatility of the low-grade bond index and the adjusted government index is the additional risk of low-grade bonds. This additional risk is the risk associated with changes in the spread between the yields on low-grade bonds and those on governments.[21]

[21] As mentioned in the text, the possibility of credit improvement increases the likelihood that an issuer will call a low-grade bond, which reduces the duration of the low-grade bond. The default-free equivalent index does not adjust for the possibility of credit improvement. If it were possible to adjust the default-free equivalent index for this factor, the volatility of this default-free equivalent index would be further reduced, leading to a greater estimate of the yield-spread risk of low-grade bonds.

C. The Relation Between Age, Maturity, and Returns of Low-Grade Bonds

The low-grade bond market is a relatively young market that has experienced rapid growth. As a result, the current composition of the market is more skewed toward recently issued bonds than one would expect of a mature market that has reached "steady state" (Figure 4). In addition newly issued bonds tend to have shorter maturities than in the past.

The empirical work of Altman (1989) and Asquith, Mullins, and Wolff (1989) suggests that the probability of default increases with the age of a low-grade bond. If so, there will be a greater default rate in the future, compared to the recent experience, as the low-grade bond market matures. Asquith, Mullins and Wolff (1989, p. 944) ask "weather market participants correctly incorporated these factors including high default rates, in the pricing of [low-grade] bonds." Implicit in this question is the possibility that the realized returns on older bonds are less than on younger bonds.

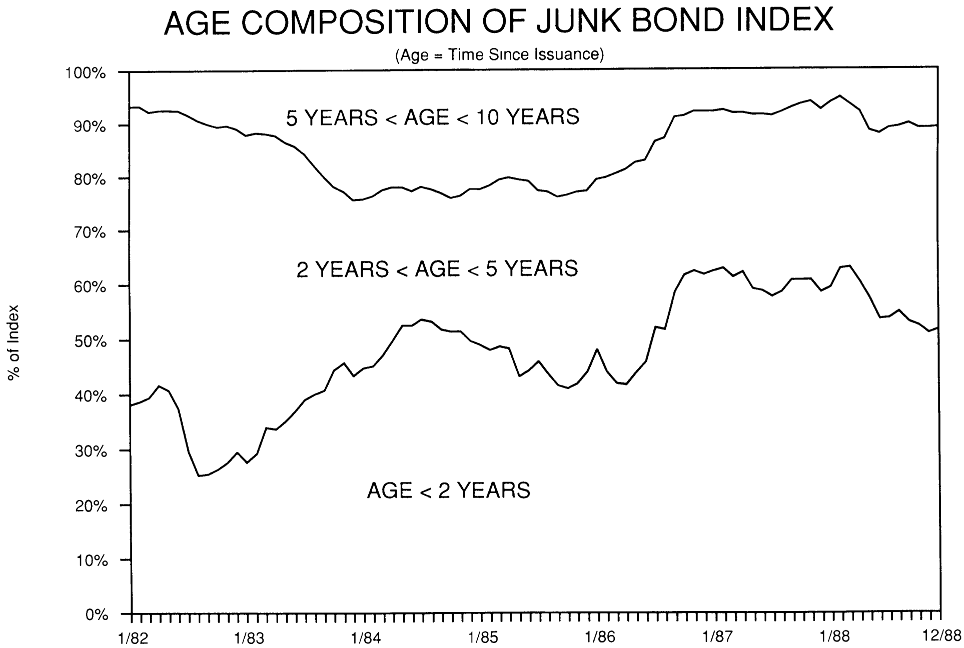
A natural way to address this possibility is to divide the sample of low-grade bonds into subindices cross-classified by maturity and age and examine the returns across subgroups. The maturity categories are two: 10 through 15 years, and 15 through 20 years. The age categories are three: 2 years old or less, 2 through 5 years, and 5 through 10 years. The calculation of the subindices for each category follows a two-step procedure: (1) for each month, assign each bond for which there is a monthly return to the appropriate subgroup; (2) for each month, average the returns for each subgroup to obtain equally weighted subindices.

There is little difference among the average returns as a function of the age of the bonds for the 1982–88 period (Table II), and formal tests of the equality of these average returns are unable to reject the hypothesis of equal expected returns.[22] As one would expect, the standard deviations tend to be larger for the bonds with longer maturity since these bonds are more sensitive to interest rate movements. There is no systematic relation between age of bond and standard deviation of the index, holding maturity constant.

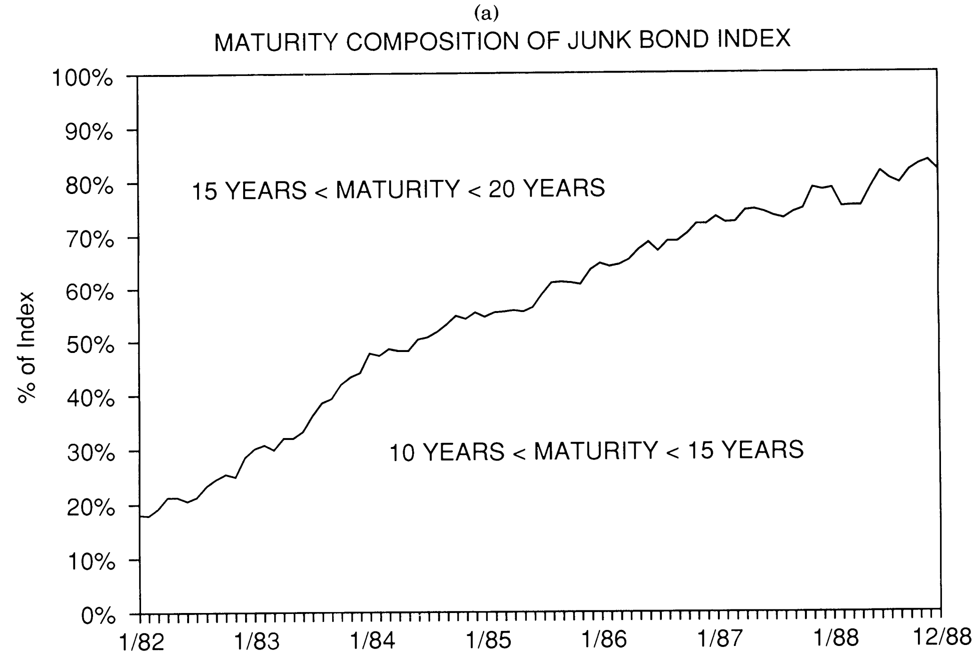
Another way to evaluate the conjecture that the prices of older bonds did not properly anticipate the subsequent default rates is to compare the actual returns realized by older bonds with the low-grade index itself. If the older bonds were overpriced initially, their subsequent realized returns should be

[22] We conducted tests of differences in means using portfolio returns and also with individual bond returns. For the latter, we adjusted the monthly returns for each bond by subtracting the overall low-grade bond index return from the individual bond return for the respective month. This removed influences common to all low-grade bonds (interest rate movements, comovement with the equity market, etc.) that may potentially confound a test of differences across bonds that is measured over time. We then estimated a panel regression of the market-adjusted returns on separate dummy variables for the age and maturity classifications. The coefficients on all the dummy variables were jointly insignificantly different from zero.

In the test using portfolio returns, we computed pairwise differences between the portfolio returns described in the text, adjusting the standard errors for potential heteroskedasticity induced by the changing number of bonds in the portfolio through time. We computed tests of the hypothesis that the differences in returns are significantly different from zero. Again, we were unable to reject the hypothesis.



(a)



(b)

Figure 4. Age and Maturity Composition of the Bonds in the Low-Grade Index from 1982 through 1988. The age composition (a) illustrates the growth over time of the number of new issues, and the maturity structure (b) indicates that the maturity of these newly issued bonds has been decreasing over these years. The low-grade bonds used in plotting this figure are those used in constructing the low-grade index and are all nonconvertible with face value at time of issue of greater than $25 million and with time to maturity of at least 10 years from the date on which a return is calculated.

Table II

Summary Statistics for Subindexes of Low-Grade Bonds Based on Years to Maturity and Age (Years since Issue) for the Period January 1982 to December 1988

These subindexes for low-grade bonds are derived from the monthly returns of individual low-grade bonds from 1982 through 1988 calculated from bid prices from Drexel Burnham Lambert and Salomon Brothers. The bonds themselves are all nonconvertible with face value at time of issue of greater than $25 million. At the beginning of each month each bond was classified into one of six categories according to its age since issue and its then current years to maturity. Averaging the returns of these bonds by category provides the monthly indexes. The table presents the average monthly returns for each category and the monthly standard deviation. Since the number of bonds for each category varies from month to month, the table contains both the range of this number and its average over the 84 months.

Age (Years Since Issue)		Years to Maturity 10 < Maturity ≤ 15	15 < Maturity ≤ 20
0 ≤ Age ≤ 2	Mean return (%)	1.27	1.38
	Standard deviation (%)	2.17	2.63
	Number of bonds		
	Range	7-88	5-44
	Average	45	24
2 < Age ≤ 5	Mean return (%)	1.35	1.11
	Standard deviation (%)	2.46	2.63
	Number of bonds		
	Range	10-38	17-59
	Average	18	34
5 < Age ≤ 10	Mean return (%)	1.29	-*
	Standard deviation (%)	2.38	-
	Number of bonds		
	Range	2-36	-
	Average	18	-

* There were only a few bonds in this category, and for some months no bond met the age and maturity requirements. Thus, it was not possible to construct a complete series of monthly returns for this category. As a consequence, the table reports no statistics for this category. When there were bonds that met the requirements, the number varied from 1 to 6 with an average of 3.

less than the returns of the low-grade index on the assumption that the more recently issued bonds are fairly priced.

In 1977 and 1978, the first two years of the modern low-grade bond market, investment bankers underwrote 78 publicly traded low-grade bonds with a total value of roughly $2.4 billion. Consider the following strategy: purchase each of the low-grade bonds issued in 1977–1978 in proportion to the value issued; sell defaulted bonds at the end of the month in which they default; reinvest all coupons, proceeds from calls, exchanges, and sales of defaulted bonds in the low-grade bond index presented in this paper; and liquidate the portfolio at the end of 1988.

By the end of 1988, the annual compounded realized return for this strategy was 10.63 percent.[23] For comparison, the compound annual rate of return for the low-grade bond index from 1977 through 1988 is 10.3 percent—slightly less. Like the previous analysis, age does not appear to be a significant factor in explaining realized returns.

D. Do Default Rates Actually Increase with Bond Age?

Both Altman (1989) and Asquith, Mullins, and Wolff (1989) conclude that default rates increase with the age of a low-grade bond. The rank correlation between age and default rates, using the data in Table III of Asquith, Mullins and Wolff, is 0.49 with a t-value of 4.58, supporting this conclusion.[24] Further analysis discloses, however, that a significant portion of the higher default rates, which appear related to the age of a bond, might better be attributed to general economic conditions. A closer examination of their data shows that the default rates were uniformly high across all age groups in several years, most notably 1985 and 1987, and uniformly low in other years, such as 1988.[25] This finding is not very surprising since general economic conditions contribute to the likelihood of default. There are more defaults in some years than others—regardless of age.

One way to remove this cyclical effect is to subtract from the raw default rate the mean default rate for the year in which the bonds defaulted. The rank order correlation between age and these mean-adjusted default rates

[23] Blume and Keim (1989) report a detailed analysis of the returns of these 78 bonds. The internal rate of return of the cash outflows in 1977 and 1978 and the cash inflow at the end of 1988 are used to approximate the realized rate of return. Blume and Keim show that this return is robust to a number of different assumptions. Of particular interest, they find that this return is not sensitive to variation in the assumptions about the liquidation value of defaulted bonds. Two extreme assumptions—a final liquidating price reported in the *S& P Bond Guide* at the end of the month of announced default, or zero—produced insignificantly different results. It is not surprising that the return on an index of low-grade bonds does not vary much with the final price attributed to defaulted bonds. Even if a bond defaults and then has no value, the realized return will still be positive if the coupons are large enough and the bond pays the promised coupon a sufficient number of times before default. For example, the annual realized return of a bond that pays coupons for eight years and then becomes valueless is −1.0 percent if the coupon is 12 percent, 2.7 percent if the coupon is 14 percent, and 6.2 percent if the coupon is 16 percent.

[24] See Blume and Keim (1989) for a more detailed discussion of this test. Briefly, they tested the null hypothesis that the rank correlation between bond age and default rate is equal to zero. To do this, first determine the age of the bonds and the ranking of default rates for each year within each cohort. For example, the 1977 cohort has twelve age categories—1 year old (i.e., 1977) through 12 years old (1988)—and twelve rankings for the magnitude of default rate in each year—one for the lowest default rate (0.0%) and twelve for the highest (19.27%). Then pool these values for each of the ten cohorts examined by Asquith et al., resulting in a sample of 75 observations. The computed Spearman rank correlation is 0.49, and the Fisher z-transform provides the test statistic.

[25] The specific analysis was to rearrange their default rates by calendar years and age of bonds rather than by year of issue and age of bond as in their Table III.

Table III

Correlations of Monthly Returns for Various Asset Classes

These statistics are based upon various indices of monthly returns. From 1977 through 1988, the bonds underlying the low-grade bond index are all nonconvertible with face value at time of issue of greater than $25 million and with time to maturity of at least 10 years from the date on which a return is calculated. The low-grade bond returns themselves come from several sources: the return of individual low-grade bonds from 1982 through 1988 are based upon bid prices from Drexel Burnham Lambert and Salomon Brothers and prior to 1982 upon prices from the *S&P Bond Guide*; the return indices from 1977 through 1988 are averages of these returns by month; for 1989 Drexel calculated a monthly return index in virtually the same way as the 1977–1988 indices were calculated, and this index was used to extend the sample through 1989. The returns for (1) the S&P 500, (2) a value-weighted portfolio of common stocks in the smallest size quintile on the NYSE, (3) the Salomon Brothers index of long-term high-grade (rated A and above) corporate bonds, and (4) long-term (approximately 20 years to maturity) government bonds are from Ibbotson Associates.

	High-Grade Bonds	Low-Grade Bonds	S&P 500	Small Stocks
A. 1/1977 to 12/1989				
Long-term government bonds	0.95	0.68	0.34	0.21
High-grade bonds		0.75	0.32	0.19
Low-grade bonds			0.48	0.52
S&P 500				0.81
B. 1/1982 to 12/1989				
Long-term government bonds	0.92	0.57	0.32	0.15
High-grade bonds		0.66	0.31	0.16
Low-grade bonds			0.52	0.51
S&P 500				0.86
C. 1/1982 to 12/1985				
Long-term government bonds	0.96	0.69	0.48	0.27
High-grade bonds		0.77	0.48	0.28
Low-grade bonds			0.60	0.48
S&P 500				0.83
D. 1/1986 to 12/1989				
Long-term government bonds	0.92	0.42	0.21	0.05
High-grade bonds		0.47	0.17	0.02
Low-grade bonds			0.49	0.55
S&P 500				0.88

drops from 0.49 to 0.22. The relation is weaker, but on the basis of a one-tail test is still significant at the 5 percent level ($t = 1.91$).[26] Thus, a substantial portion of the previously observed relation of age and default rates is due to cyclical effects.

[26] The details of this test are the same as those described in footnote 25, except that the default rankings are now based on the mean-adjusted default rates.

II. Covariability of Low-Grade Bond Returns

In addition to the analysis of the returns and volatility of the low-grade bond index, we analyze the covariability of the returns of these bonds with the returns of other asset groups. This analysis shows that low-grade bonds exhibit some of the characteristics of high-grade bonds and some of the characteristics of stocks. From 1977 through 1989, the correlation between low-grade bonds and long-term Treasury bonds is substantially less than the correlation between long-term high-grade corporates and Treasury bonds—0.68 and 0.95, respectively (Table III). The correlation between low-grade bonds and small stocks is substantially greater than the correlation between long-term high-grade corporates and small stocks—0.52 and 0.19, respectively. The correlations for the other subperiods reported in Table III behave similarly. This pattern of correlations implies that low-grade bonds are less sensitive to interest rate movements and more sensitive to equity market movements than high-grade bonds. As such, analysis of expected returns (and thus abnormal returns) for low-grade bonds is complicated by the fact that the "risk" of these bonds must capture sensitivity to both interest rate and equity fluctuations, and we currently have no models that explicitly account for both of these influences.

Our objective is modest. We analyze the contribution of interest rate and stock market fluctuations to low-grade bond return variance through a series of regressions using the monthly return on the low-grade bond index as the dependent variable. The independent variables include returns from various combinations of the long-term government bond index and the small stock index.[27] Also included are two dummy variables to reflect temporal or seasonal patterns in the low-grade bond returns. The first is a variable that has a value of one for January observations and zero otherwise. This variable reflects the mounting evidence that the process generating returns may be different in January from other months. For example, Keim and Stambaugh (1986) find a significant January seasonal in the risk premiums of low-grade bonds as well as smaller stocks.[28] The second dummy variable has a value of one for October 1987 and zero otherwise. October 1987 was a month of considerable turbulence, and the normal relations between the different markets may have temporarily changed.

The regressions for both the 1977–1989 and the 1982–1989 period lead to similar conclusions (Table IV) and will be discussed together.[29] Both the

[27] We also estimated regressions using the S&P 500 index in place of the small stock index and the long-term high-grade corporate index in place of the long-term government index. The results are very similar.

[28] In addition to this relation in January, Keim and Stambaugh (1986) find that the premium of low-grade over high-grade bonds and the premium of small over large stocks are correlated for all months over the 1928–1977 period. We confirm this for the 1977–89 period with a correlation of 0.45. This is further evidence that equity price movements, and in particular price movements of small stocks, may influence low-grade bond price volatility.

[29] The same regressions are estimated for each half of the 1982–1989 period and lead to conclusions similar to the overall period. These results are not reported to conserve space.

Table IV

Regressions of Low-Grade Bond Returns on Bond and Stock Market Returns and Dummy Variables for Various Dates

In these regressions the low-grade bond index is based upon nonconvertible bonds with face value at time of issue of greater than $25 million and with time to maturity of at least 10 years from the date on which a return is calculated. The returns themselves for the individual low-grade bonds from 1982 through 1988 are based upon bid prices from Drexel Burnham Lambert and Salomon Brothers and prior to 1982 upon prices from the *S&P Bond Guide*. The return indices from 1977 through 1988 are averages of these returns by month. For 1989 Drexel calculated a monthly return index in virtually the same way as the 1977–1988 indices were calculated, and this index was used to extend the sample through 1989. The returns for long-term government bonds and the value-weighted portfolio of common stocks in the smallest size quintile on the NYSE come from publications of Ibbotson Associates. The dummy variable for October 1987 has a value of one for this month and zero otherwise. The dummy variable for January has a value of one for these months and zero otherwise. The numbers in parentheses are t-values.

	Intercept	October 1987 Dummy	January Dummy	Government Bond Total Return	Small Stocks Total Return	$\bar{R}^2$
A. 1977–1989	0.31	−6.26	1.88	0.51		0.53
	(2.04)	(−18.76)	(2.89)	(9.67)		
	0.33	4.53	0.72		0.26	0.28
	(1.72)	(3.95)	(1.21)		(6.86)	
	0.11	−0.75	1.31	0.45	0.17	0.62
	(0.75)	(−0.75)	(2.41)	(8.49)	(6.11)	
B. 1982–1989	0.53	−5.73	1.57	0.40		0.41
	(2.95)	(−15.79)	(1.83)	(6.57)		
	0.70	4.08	0.94		0.26	0.28
	(3.21)	(2.38)	(1.41)		(4.62)	
	0.39	−0.11	1.05	0.33	0.17	0.50
	(2.12)	(−0.06)	(1.45)	(5.21)	(3.17)	

government returns and the small stock returns, whether included together or separately, are significant. Replacing the government returns with the high-grade corporate returns leads to greater R^2s (not presented in the table), suggesting that a component in the variation in low-grade returns, in addition to the pure interest and equity effects, is in part captured by the returns for high-grade corporate bonds. These results support the conjecture that low-grade bonds are a hybrid security with features of both bonds and stocks.

The coefficient on the January dummy is consistent with a January seasonal of 1 to 2 percent. In the regressions that include only bond returns and the dummy variables, the coefficient is positive for both periods, but significant only for the 1977–1989 period. In the regressions that include only small stock returns and the dummy variable, the coefficient on the dummy variable is less than 1 percent and is not significant at the usual levels. This suggests that the January dummy is redundant when combined with the small stock returns that already contain a significant January seasonal. However, in the regressions including both bond returns and stock returns, the coefficient on the January dummy variable is significant in the overall period. This behavior of the coefficients suggests that there is an interaction among the bond returns, the stock returns, and the month of January that the regressions do not fully capture-a possible subject for future research.

The coefficient on the dummy variable for October 1987 is negative and significant in the regressions that exclude equity returns but is positive and significant in the regressions that include only equity returns. This pattern in the values of the coefficients on this dummy variable is consistent with an interpretation of low-grade bonds as hybrid securities. In October 1987 the return on the low-grade bond index is less than predicted by the normal relation of these bonds to governments and high-grade corporates but greater than that predicted by their normal relation to small stocks. In the regressions that include both bond returns and stock returns the coefficient on the dummy variable is no longer significant.

Thus, low-grade bonds are complex securities having some of the characteristics of higher grade bonds and some of the characteristics of equities. Any model for pricing low-grade bonds needs to capture both fixed income and equity characteristics.

III. Are Low-Grade Bonds Fairly Priced?

Prior to 1989, much discussion (mostly in the popular press) focused on the "inefficiency" of the low-grade bond market. The popular story was that the returns of low-grade bonds were well in excess of that required to compensate for their relatively low "risk" as measured by the historical volatility of well-diversified portfolios of such bonds.

A limited number of studies have examined whether low-grade bond returns provide fair compensation for the risks involved. Weinstein (1987) examines a sample of "fallen angels" for the 1962-1974 period. Before adjusting for interest rate volatility, he finds that these "fallen angels" have low betas (0.023) and significant abnormal returns (alphas) relative to a value-weighted CRSP stock market index. After adjusting for interest rate volatility, the abnormal returns are no longer significant. Weinstein concludes that low-grade bonds are "fairly priced."

Turning to the more recent period, Blume and Keim (1987) estimate a market model regression for the sample of low-grade bonds used in this paper but for the 1977-1986 period. They find insignificant alphas and, in contrast to Weinstein's sample of fallen angels for the earlier period, an estimated beta of 0.34 relative to the S&P 500. Cornell and Green (1990) estimate multiple regressions similar to those reported in Section III above and conclude that low-grade bonds are sensitive to both interest rate and stock market fluctuations, but they do not directly address whether the bonds are fairly priced.

Kaplan and Stein (1990) employ a clever technique to extract the beta (relative to the stock market) for low-grade bonds associated with highly leveraged recapitalizations from stock betas estimated before and after the recapitalization. They estimate the beta for their sample of low-grade bonds to be 0.57. After making assumptions about the stock market risk premium and default experience in the low-grade bond market, Kaplan and Stein (1990 p. 6) conclude that the low-grade bonds in their sample "do not receive adequate compensation for the risk they bear." Since their sample contains only twelve bonds and covers the limited period 1985–1988, one should view this conclusion as tentative and subject to further verification.

This section addresses the efficiency of the low-grade bond market in a very specialized and limited context. Consider an investor who holds a portfolio consisting of risky assets and a risk-free asset. The risky-asset portion is a portfolio of stocks and both high-grade and low-grade corporate bonds, weighted roughly in proportion to their market weights. If the expected return on low-grade bonds exceeds that justified by their systematic risk, the investor could obtain a more efficient portfolio by shifting the composition of the risky-asset portion of the portfolio toward additional investment in low-grade bonds, and thus, overweight this segment of the risky portfolio in comparison to market weights. Of course, such a shift might require an adjustment in the investment in the risk-free asset to readjust the overall risk of the portfolio.

Blume (1984) shows that the standard "alpha" coefficient can be used to determine whether an investor who currently holds a portfolio, say P, could obtain a more efficient portfolio by shifting some of P into an alternative asset group, say A. Consider the portfolio problem of minimizing the variance of a portfolio consisting of P and A subject to a wealth constraint and an expected return constraint. With some manipulation, the proportion to place in A is

$$x_A = k_{AP}[E(r_A) - \beta_{AP}E(r_P)] = k_{AP}\alpha_{AP} \tag{1}$$

where $E(r_P)$ and $E(r_A)$ are the expected returns of P and A in excess of the riskfree rate, k_{AP} is a positive number determined by the moments of P and A, and β_{AP} is $Cov(r_A, r_P)/Var(r_P)$. Thus, if α_{AP} is not zero, the sign of α_{AP} determines whether an investor who currently holds P should take a long or short position in A. The alphas associated with different alternative assets cannot be directly compared since k_{AP} varies from one alternative to another.

If the expected returns on low-grade bonds are substantially in excess of that warranted by their systematic risk, an investor who currently holds a market-weighted portfolio of equities, high-grade corporates, and low-grade corporates would want to shift a portion of the investment in the first two asset categories into low-grade bonds, thereby overweighting the low-grade category. If so, α_{AP} would be positive.

Our estimate of α_{AP} assumes that the risky-asset portion of the portfolio P consists of 75 percent stocks, 20 percent high-grade bonds, and 5 percent low-grade bonds.[30] The indices used to measure the returns of the three asset

[30] As of the end of 1989, SEI estimates that the typical balanced institutional portfolio contained 49.5 percent in equities. The portfolio used in the text slightly overweights equities in terms of this statistic and underweights bonds. The effect is to bias the alpha coefficients upwards, favoring the conclusion that low-grade bonds are underpriced.

categories are the same as those in Table I. The alternative portfolio (i.e. dependent variable) is the low-grade bond index. Thus, a positive α_{AP} indicates that the investor should overweight low-grade bonds; with a negative α_{AP} the investor should underweight low-grade bonds.

To account for the possibility of nonsynchronous or stale prices, the regression estimates of α_{AP} and β_{AP} use the Scholes-Williams (1977) adjustment. The results without this adjustment are for the most part similar (Table V). For the entire period 1977-89, the alpha coefficient for low-grade bonds is negative but not significant at the usual level of 5 percent. For comparison, Table V contains a replication of this analysis but uses long-term high-grade corporates as the alternative investment. The alpha coefficient for high-grade corporates is also statistically indistinguishable from zero.

The estimated alpha coefficients vary substantially across subperiods for both low-grade and high-grade corporate bonds. From 1982 through 1989, the alphas for both types of bonds are positive but again insignificant. In the first half of this period, 1982-1985, the alpha for low-grade bonds is positive, while in the second half, 1986-1989, the alpha is negative. In contrast, the alpha for long-term high-grade corporates is positive in both subperiods, 1982-1985 and 1986-1989.

If low-grade bonds were significantly underpriced relative to a portfolio of equities, one would expect to see consistently large alpha coefficients and if overpriced, large negative alpha coefficients. Instead, the alpha coefficients for low-grade bonds are insignificant and fluctuate between positive and negative numbers. This evidence provides little support for the notion that these bonds are systematically under- or overpriced relative to a market-weighted portfolio of equities and bonds.

IV. Conclusion

This paper examines the risk and return characteristics of low-grade bonds with a new data file of dealer bid prices for the most actively traded bonds in the market. The following three findings characterize the low-grade bond market for the period 1977-1989:

(1) A diversified portfolio of low-grade bonds with more than 10 years to maturity exhibits less volatility than indices of long-term Treasury bonds, long-term high-yield corporate bonds, S&P 500 stocks, and small stocks. This perhaps unexpected result is attributable in large part to the lower sensitivity of low-grade bonds to unexpected changes in interest rates. A comparison of the volatility of low-grade bonds to the volatility of equivalent government bonds (equivalent in terms of coupons, call features, and maturity) shows that low-grade bonds are more volatile.

(2) Previous research has intimated that differences in the age of low-grade bonds may be associated with significant differences in their returns. Examination of subsamples of our data based on age and maturity reveals no evidence of a relation between the age of low-grade bonds and their return distributions. Further, analysis of the default data suggests that at least part

Table V

Regression of Excess Returns of Low-Grade and High-Grade Bonds on the Excess Returns of a Reference Portfolio Consisting of 75 Percent Stocks, 20 Percent High-Grade Bonds, and 5 Percent Low-Grade Bonds, Various Dates

In these regressions all returns are measured in excess of the Treasury Bill rate as given in the publications of Ibbotson Associates. From 1977 through 1988, the bonds underlying the low-grade bond index are all nonconvertible with face value at time of issue of greater than $25 million and with time to maturity of at least 10 years from the date on which a return is calculated. The returns of individual low-grade bonds from 1982 through 1988 are based upon bid prices from Drexel Burnham Lambert and Salomon Brothers and prior to 1982 upon prices from the *S&P Bond Guide*. The return indices from 1977 through 1988 are averages of these returns by month. For 1989 Drexel calculated a monthly return index in virtually the same way as the 1977-1988 indices were calculated, and this index was used to extend the sample through 1989. The returns for long-term government bonds and the S&P 500 come from publications of Ibbotson Associates. As demonstrated in Blume (1984), the alpha coefficient of an alternative portfolio with respect to a reference portfolio has the following interpretation: a positive alpha indicates that an investor who currently holds the reference portfolio as the risky portfolio in conjunction with an investment in a risk-free asset could increase expected utility by shifting some of the risky portfolio into this alternative portfolio with a further adjustment to the risk-free investment; a negative alpha indicates that the investor should take a short position in the alternative portfolio; and an alpha of zero indicates no change. The table reports OLS regressions and also OLS regressions using the Scholes-Williams (1977) adjustment for nonsynchronous trade prices. The numbers in parentheses are t-values.

		Scholes-Williams		OLS Regression		
Date	Alternative Bond Portfolio	α	β	α	β	$\bar{R}^2$
1/1977 to 12/1989	Low-grade	−0.109	0.538	−0.039	0.435	0.376
		(−0.55)	(12.96)	(−0.23)	(9.65)	
	High-grade	−0.089	0.529	−0.074	0.470	0.274
		(−0.33)	(9.26)	(−0.31)	(7.62)	
1/1977 to 12/1981	Low-grade	−0.315	0.640	−0.253	0.568	0.400
		(−0.81)	(6.19)	(−0.76)	(6.13)	
	High-grade	−0.607	0.622	−0.662	0.609	0.321
		(−1.21)	(4.67)	(−1.56)	(5.16)	
1/1982 to 12/1989	Low-grade	0.089	0.490	0.187	0.348	0.374
		(0.41)	(11.60)	(1.00)	(7.60)	
	High-grade	0.333	0.484	0.410	0.362	0.230
		(1.13)	(7.76)	(1.50)	(5.39)	
1/1982 to 12/1985	Low-grade	0.270	0.707	0.453	0.469	0.506
		(0.96)	(10.99)	(1.80)	(6.96)	
	High-grade	0.291	0.838	0.479	0.629	0.434
		(0.77)	(8.39)	(1.22)	(6.02)	
1/1986 to 12/1989	Low-grade	−0.165	0.323	−0.116	0.256	0.300
		(−0.58)	(5.95)	(−0.46)	(4.43)	
	High-grade	0.260	0.196	0.256	0.166	0.093
		(0.70)	(2.71)	(0.77)	(2.17)	

of the observed tendency for the probability of default to increase with the age of a bond is due to cyclical conditions in the credit market that affect all bonds regardless of their age. Thus, the relation of default to the age of a bond is weaker than previous studies suggest.

(3) The returns of low-grade bonds display properties of both bonds and stocks and thus are more complex than for high-grade corporate bonds. Any model used to explain the expected returns of these bonds should reflect both interest rate and equity factors. Despite this complexity, there is no evidence that low-grade bonds are significantly over- or underpriced.

APPENDIX

Monthly Returns (Percent) for Low-Grade Bond Index

These returns are based on several indices. From 1977 to 1988, the bonds underlying the index are all nonconvertible with face value at time of issue of greater than $25 million and with time to maturity of at least 10 years from the date on which a return is calculated. The returns for the individual bonds from 1982 through 1988 are based on bid prices from Drexel Burnham Lambert and Salomon Brothers and prior to 1982 on prices from the S&P BOND GUIDE. The return indices from 1977 through 1988 are averages of these returns by month. For 1989 Drexel calculated a monthly return index using bid prices in virtually the same way as the 1977-1988 indices were calculated, and this index was used to extend the sample through 1989.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1977	2.20	1.90	0.00	0.90	1.80	3.30	−0.30	0.30	−1.60	0.20	2.30	0.10
1978	−1.30	0.30	1.30	0.00	−1.10	1.00	1.20	2.90	0.70	−5.80	0.80	−1.20
1979	5.10	−0.10	2.00	0.50	0.50	1.80	0.90	0.80	−2.10	−8.10	3.20	−1.20
1980	−1.30	−6.00	−5.70	13.00	6.60	3.30	−1.90	−2.30	−1.30	0.40	−1.20	−1.00
1981	2.80	−1.20	2.00	−0.70	0.50	3.80	−3.10	−2.20	−2.90	3.50	8.40	−2.50
1982	−1.85	1.36	0.63	2.47	2.11	−1.08	4.30	8.67	3.76	4.62	2.71	1.29
1983	5.48	4.09	4.07	3.99	−2.32	−0.51	−1.61	0.94	2.42	1.10	1.29	−0.41
1984	3.76	−1.30	−1.05	−0.94	−4.60	1.20	3.05	2.05	4.00	2.88	0.67	−0.09
1985	3.91	1.17	0.81	1.38	4.43	0.87	0.23	1.55	0.56	0.30	2.44	3.17
1986	0.64	3.33	2.57	2.36	−0.89	3.06	−2.90	1.68	1.08	1.36	0.30	0.43
1987	4.04	2.15	0.23	−3.00	−0.27	0.65	−0.27	1.61	−3.82	−2.74	2.14	1.65
1988	4.10	3.59	−1.03	0.67	0.70	3.09	1.10	0.39	2.27	1.29	0.14	0.39
1989	2.03	0.21	−0.47	−0.05	1.24	2.26	0.00	−0.39	−1.79	−5.70	0.38	0.31

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