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Default Risk, Mortality Rates, and the Performance of Corporate Bonds

The Research Foundation of
The Institute of Chartered Financial Analysts

ISBN 10-digit: 0-943205-56-5 ISBN 13-digit: 978-0-943205-56-4

Printed in the United States of America

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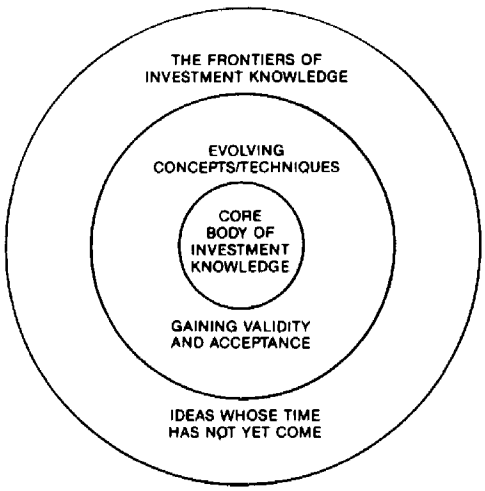

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FOREWORD

Upon a first, second, or third reading of Altman's study, one is inclined to be effusive and say this is everything one needs to know about bond defaults, high-yield debt, and yield spreads. The study is that thorough and the analysis is that keen. Yet experience teaches us that studies such as this are as valuable as they are because they open so much new ground, thus leaving more to be said.

Until recently, almost everyone estimated bond defaults in the same way. The emergence of high-yield debt, both the glory and the bane of investors, depending on the point of view, refocused our attention on determining default risk, a seemingly simple concept. Altman shows us that the concept itself is heavily nuanced, and analysts cannot go willy-nilly along the prior analytical paths.

Altman does us the great favor of methodically telling us what the major issues of default bond analysis are, providing new insights and titillating us with what he knows is yet to be studied. Due diligence is needed to navigate the study's terrain, however. The outline is sensible, direct, and straightforward. But it is precisely these qualities that demand our close attention, for some of the subtleties may be easily missed. In the end, the rewards for our efforts are twists that are as refreshing as they are insightful. Our thought processes are expanded, and we are better analysts for it.

All investment professionals, not just bond specialists, are heavily in Altman's debt. The Research Foundation is proud to be a party to the work of this scholar. Altman has shed much light on a topic that is likely to continue to be around for some time to come.

Charles A. D'Ambrosio, CFA
The Research Foundation of the
Institute of Chartered Financial Analysts

Preface

One of the pervasive aspects of scientific inquiry and research is the cumulative nature of progress. Most new works build on existing technology and findings to better understand some phenomenon. Such is the case for this research project.

For a long time, dating back to the years prior to the Depression, financial fixed-income security researchers analyzed risk and return by assessing performance on an annual basis. Averages over time were compiled and compared for a variety of corporate securities and the risk-free government security sector. In 1958, W. Braddock Hickman published his opus on the performance of corporate debt securities, including low-grade and defaulting issues. Of course, the stimulus for concentrating on default-related issues came from problems related to the Great Depression. Renewed impetus for studies comparing risk and return attributes of corporate debt has been manifested more recently with the growth and increased importance of the high-yield, "junk" bond market.

Beginning in the late 1970s, a number of studies chronicled default rates and losses of corporate debt, including the high-yield, high-risk market. These studies, including several by this author, documented annual default rates, losses, and returns of securities grouped into risk-free, investment-grade, and non-investment-grade categories. These data served a number of purposes, including comparing performance, justifying investment in various risk-asset classes, and setting appropriate loss reserves for investors. Because the results tended to favor the lower-rated securities, some practitioners naturally used them to justify increased supply and demand in the junk bond market.

Concurrent with the publication of these traditionally calculated performance numbers, I received a number of inquiries on the performance of bonds by specific bond-rating categories rather than by investment- and non-investment-grade classes. In addition, it seemed relevant to look at default rates and losses on portfolios of debt securities over time and not just on an annual basis. Because the length of time a security is held is critical to performance, it seemed appropriate to analyze fixed-income securities based on time held from issuance for all rating classes. Borrowing from insurance actuarial mortality and survival "technology," we set out to construct an alternative method for analyzing default rates, losses, and corporate bond performance. The result of this inquiry is found in the body of this report.

I would like to express my appreciation to David Goodman, Daniel Kingsbury, Lee Yut Khoon, Jeffrey Klearman, Kola Luu, and Alice Markowski for their data assistance and manuscript preparation, and to Professor Aaron Tenenbein for his valuable comments. I am most appreciative of the financial support for this research supplied by the Research Foundation of the Institute of Chartered Financial Analysts. The study is based on data and information available to the public. The results are solely the work and opinion of the author. A shorter version of this paper was published in the *Journal of Finance* in September 1989.

My inquiries into corporate debt security performance are certainly not complete with the publication of this study. For one thing, we assume a buy-and-hold strategy in our measurement of performance. We do not consider credit-quality changes, except when they result in a default. Subsequent research will, I hope, integrate these rating transitions into the analysis.

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October 1989

1. Introduction

The recent emergence of the U.S. high-yield corporate debt market has intensified interest in and research into the relation between expected yield spreads of bonds of various credit quality and expected losses from defaults. In addition to default risk, investors also consider the effects of the two other major risks of investing in fixed-income instruments: interest-rate risk and liquidity risk. Both the heightened appreciation of the sensitivity of duration to interest-rate levels and changes and periodic liquidity crises have captured the attention of practitioners as well as researchers. The interaction among the three risks has raised the analytic content of fixed-income assessment to an increasingly sophisticated level. The analysis of default risk, however, has probably been the focus of most concern and empirical research since the initial pioneering work by Hickman (1958).

The appropriate evaluation of default risk and the accuracy of measuring it are critical to (1) the pricing of debt instruments, (2) the measurement of their performance, and (3) the assessment of market efficiency. Analysts have concentrated their efforts on measuring the default rate for finite periods of time—for example, one year—and then averaging the annual rates for longer periods. In almost all previous studies, the default rate was measured simply as the value of defaulting issues for some specific population of debt compared with the value of bonds outstanding that could have defaulted. Annual defaults are then usually compared with observed promised yield spreads to assess the attractiveness of particular bonds or classes of bonds. Another approach would be to compare default rates with *ex post* returns to assess whether investors were compensated for the risks they accepted. A third approach would be to estimate the default risk premium included in the price of a

bond—that is, the required risk premium—and to compare that premium with the actual default experience of a particular quality class of debt.

This study explores further the notion of default risk by developing an alternative way of measuring that risk and by suggesting an appropriate method of assessing the performance of fixed-income investment strategies over the entire spectrum of credit-quality classes. The approach used in this study measures the expected mortality of bonds in a way similar to that used by actuaries to assess human mortality. The word "mortality" refers specifically to a life expectancy, or survival rate, for various periods of time, not necessarily for one year. Although it is informative to measure default rates and losses based on the average annual rate and loss method, that traditional method has at least two deficiencies. It does not consider that there are other ways in which a bond dies, namely redemptions from calls, sinking funds, and maturation, nor does it address the question of the probability of default for various time periods in the future on the basis of an issue's attributes at issuance. In particular, this study seeks to specify an appropriate method and to present empirical results to answer the following:

Given an issue's initial bond rating:

(1) What is the estimated probability of default and loss from default over a specific time horizon of one year, two years, three years, or N years?
(2) Contingent on the successful payment of interest and sinking fund, if any, over a specified period of time, what is the probability of default over some future finite period?
(3) What are the estimates of the cumulative annual mortality rates and losses for various time frames as well as the marginal rates for specific one-year periods?
(4) Given estimates of cumulative mortality losses suffered by investors and expected return spreads earned on the surviving population of bonds, what are the simulated net return spreads earned or lost in comparison with returns on risk-free securities?

The balance of this study is organized as follows. In Chapter 2, relevant early studies dealing with default rates and risk premium analysis of corporate bonds are reviewed. In Chapter 3, traditional methods of measuring default rates and losses and the historical experience of defaults in the 1900-88 period

are discussed. Chapter 4 includes an analysis of the issues that are not resolved by traditional measures and presents a method of assessing the mortality rates and losses on straight corporate debt. In Chapter 5, the observed empirical results of mortality rates on all corporate bonds for periods up to 10 years after issuance are presented. Results cover bonds issued from 1971-87 and defaults from 1971-88. The investment performance for the various bond-rating categories is presented, including data on historical yield spreads, new issue amounts, and various kinds of bond mortalities. In Chapter 6, several important default-related studies that have been completed in the most recent months and which either comment upon or are directly related to earlier drafts of our mortality rate findings are reviewed. In the final chapter, the implications of these results are discussed.

2. Prior Studies

Previous studies of default were of three general types. The first type, which might be called "Hickman-style" studies, usually presented statistics on annual and life-span default rates and actual returns to bondholders over various time frames. Hickman's work (1958), which covered the period 1900-43, was updated by Atkinson (1967). In general, the studies concluded that investors in corporate bonds had been well compensated for the risks incurred, especially in low-rated debt.

The second type of study emphasized the default-risk potential of individual- company debt by examining the determinants of risk premiums over risk-free securities (Fisher 1959), or by constructing univariate (Beaver 1967) or multivariate classification models (Altman 1968, and others) based on the combination of micro-finance measures and statistical classification techniques, such as discriminant and logit-probit analysis. Variants on those models were based on the "gambler's ruin" concept (Wilcox 1971), recursive partitioning techniques (Frydman, Altman, and Kao 1985), and market indicators of survival (Queen and Roll 1987). The latter study is particularly relevant because it introduced to finance the firm mortality concept and emphasized the distinction between favorable and unfavorable disappearance. An example of favorable disappearance would be a merger in which stockholders were bought out at a healthy premium. Our measure of the mortality of bonds has some similar qualities in that we adjust the population for various kinds of redemptions. We do not, however, attempt to measure the effects of sinking fund or call probabilities on required risk premiums.

Finally, Fons (1987) attempted to combine observed pricing and the inherent default risk premium with estimates of corporate bond default

experience. Fons incorporated default experience measured by Altman and Nammacher (1985, 1987) and others with a risk-neutral investment strategy—that is, where the only factor that matters is the return distribution on debt, with no relevance for volatility or liquidity factors. Using all low-rated debt combined, he assessed the default premium expected and concluded that investors holding a well-diversified portfolio of low-rated bonds were well rewarded for bearing the implicit default risk. Blume and Keim (1987) reached similar conclusions by observing return spreads after default and comparative volatility patterns between low-rated and investment-grade debt portfolios.

Fons did not believe, however, that default rates on particular bond-rating classes could be meaningfully addressed because the ratings are not permanent designations and because bonds are usually downgraded prior to default. Yet, it does appear to be relevant to measure losses to investors by original investment in specific bond-rating categories. The assumption implicit in our analysis is that of a buy-and-hold strategy for various time horizons, with specific year-by-year observations of default losses and return spreads on the surviving population.

3. Traditional Measures of Default Rates and Losses

Accurate measurement of default risk is central to our discussion of the trade-off between required risk premiums on bonds of different credit-quality and returns on those securities. The market has pretty much accepted the distinction between so-called investment-grade and non-investment-grade categories. At the same time, bonds receive more precise ratings with four classes for investment-grade debt and essentially three classes for lower-quality junk bonds. Despite the finer distinctions, all published analytical works concentrate on either the entire corporate-bond universe or just the high-yield, non-investment-grade sector. Default rates are calculated on an average annual basis, with individual rates for each year combined with rates for other years over some longer time horizon to form the estimate for the average annual rate.[1] Each year is usually given equal weighting in calculating the average.

Default Rates

Table 1 shows the average annual default rate compilation on *low-rated* debt for the period 1970-88 and for shorter intervals within the entire 19-year period. The average annual default rate for the period 1978-88 was 1.92 percent. Table 2 lists the average annual default rate on *all* corporate straight debt for selected periods from 1900 through 1988.[2]

[1]The rate for each year is based on the dollar amount of defaulting issues in that year divided by the total population outstanding as of some point during that year.

[2]The reader is cautioned that estimates are not strictly comparable because various researchers used somewhat different criteria for measuring default rates. Nevertheless, the data are instructive and permit the reader to observe trends over a long period.

TABLE 1

Historical Default Rate—Low-Rated, Straight Debt Only 1970-88

Year	Par Value Outstanding ($ millions)	Par Value Default ($ millions)	Default Rate (Percent)
1989*	201,000	5,304.50	2.639
1988	159,223	3,944.20	2.477
1987	136,952	7,485.50(1,841.70)[1]	5.466(1.34)[2]
1986	92,985	3,155.76	3.394
1985	59,078	992.10	1.679
1984	41,700	344.16	0.825
1983	28,233	301.08	1.066
1982	18,536	577.34	3.115
1981	17,362	27.00	0.156
1980	15,126	224.11	1.482
1979	10,675	20.00	0.187
1978	9,401	118.90	1.265
1977	8,479	380.57	4.488
1976	8,015	29.51	0.368
1975	7,720	204.10	2.644
1974	11,101	122.82	1.106
1973	8,082	49.07	0.607
1972	7,106	193.25	2.720
1971	6,643	82.00	1.234
1970	6,996	796.71	11.388

Average Default Rate

1970 to 1988	2.404
1974 to 1988	1.981
1978 to 1988	1.919
1983 to 1988	2.485

Notes: *Through October 15, 1989.

[1]$1,841.70 million is the par value-default amount without Texaco, Inc., Texaco Capital, and Texaco Capital N.V.

[2]The default rate without the Texaco defaults (see Note 1) is 1.34 percent.

TABLE 2

Corporate Debt Default Rates 1900-1988

Period	Total Corporate Debt Default Rate (Percent)
1900-09	0.90
1910-19	2.00
1920-29	1.00
1930-39	3.20
1940-49	0.40
1950-59	0.04
1960-67	0.03
1968-77	0.16
1978-88	0.28

Default Losses

The more relevant default statistic for most investors is the amount lost from defaults, not the rate of default.[3] Altman and Nammacher (1987) measured the amount lost from defaults by tracking the price for the defaulting issue just after default and assuming the investor had purchased the issue at par value and sold the issue just after default. It was also assumed that the investor would lose one coupon payment. Table 3 illustrates the calculation of default losses for 1988. For example, the loss from principal is calculated by multiplying the default rate (2.480 percent) by the loss of principal (56.83/100 percent), which equals 1.409 percent. To this is added the loss from the missed coupon payment, which is calculated as follows: the default rate of 2.48 percent is multiplied by one-half the coupon rate [2.48 + (0.5 x .1132)]. Adding that to the loss from principal yields the default loss of 1.550 percent. Market weighted calculations yield about the same, in this case.

[3]An additional item of importance is the amount lost not just from defaults but also from other crisis situations, such as distressed exchange issues. Fridson, Wahl, and Jones (1988) looked at the loss on distressed exchange issues as well as losses from defaults and found that the overall average annual loss for the period 1978-87 was 1.88 percent, with 0.12 percent per year contributed by exchange losses on issues which did not later default. Their base and reference population was only original-issue high-yield debt.

TABLE 3

Default Loss to Investors in 1988 (Based on 69 Defaulting Issues)

		Arithmetic Calculation	Weighted Calculation
Background Data			
Average Default Rate 1988	=	2.48%	2.48%
Average End of Month Price After Default	=	43.17	43.61
Average Loss of Principal	=	56.83%	56.39%
Average Coupon Payment	=	11.32%	11.91%
Median Coupon Payment	=	11.75%	
Default Loss Computation			
Default Rate		2.480%	2.480%
X Loss of Principal		0.568	0.564
Loss from Principal		1.409%	1.398%
+ 1/2 Coupon X Default Rate		0.140%	0.148%
Default Loss 1988		1.550%	1.546%

1974-88 Statistics	Loss	Number of Years	Weight
Default Loss 1974-87	1.135%	14	0.933
Default Loss December 1988	1.546%	1	0.067
Average Default Loss 1974-88 (Equal Annual Weight)	1.162%	15	1.000

The average annual default loss over the sample period 1978-88 has been approximately 1.3 percent per year and 1.16 percent for 1974-88, with the rate slightly higher at 1.65 percent for the most recent four years (1985-88) and 1.55 percent in 1988. For the first 10 months of 1989, the loss rate was 1.61 percent. That lower percentage of loss compared with default rates arises because the defaulting debt, on average, sells for slightly less than 40 percent of par at the end of the defaulting month.[4] The recovery rate in 1988 was 43.6 percent.

Returns Net of Defaults

The primary purpose of examining default rates and the consequent loss to investors is to assess the performance of net returns. Table 4 lists the annual arithmetic and compound average returns on portfolios of high-yield bonds and long-term Treasury securities and the spread between the two portfolios. Although the spreads vary from year to year based on such factors as interest-rate movements, default losses, and market-specific factors, we observe that the compound average return spread over the period 1978-88 was about 2.41 percent per year, which is roughly the difference between the promised yield spread of 3.86 percent per year and the average annual loss from defaults of about 1.30 percent.

The relatively long period of performance comparison demonstrates superior historical performance of high-yield bonds over long-term Treasuries. Although this is no guarantee of future return performance, it is one basis for forming expectations. We will examine an alternative approach at a later point.

Questions Related to the Traditional Method

Although the traditional method for assessing default rates and losses has considerable relevance for fixed-income security performance, it involves controversial questions and potential biases. For instance, although the most recent history of defaults is immensely useful to portfolio managers and other investment officers for assessing the subsequent-year loss rate and for setting

[4]An excellent example of the possible large difference between default rates and losses is our 1987 experience when the rate was 5.47 percent but the loss was about 1.64 percent. The difference stems from the fact that Texaco's bonds sold in the mid-80s just after default, compared with a norm of about 40 for defaulting issues. The default loss is calculated on a value-weighted average basis.

TABLE 4

Annual Returns, Yields, and Spreads on Long-Term Government and High-Yield Bonds

	Return (%)			Promised Yield (%)[3]		
Year	High-Yield[1]	Long-Term Government[2]	Spread	High-Yield	Long-Term Government	Spread
1989	N/A	N/A	N/A	13.21	9.17	4.04
1988	13.47	9.20	4.27	13.95	9.00	4.95
1987	4.67	(2.67)	7.34	12.66	8.75	3.91
1986	16.09	24.08	(7.99)	14.45	9.55	4.90
1985	22.51	31.54	(9.03)	15.40	11.65	3.75
1984	8.50	14.82	(6.32)	14.97	11.87	3.10
1983	21.80	2.23	19.57	15.74	10.70	5.04
1982	32.45	42.08	(9.63)	17.84	13.86	3.98
1981	7.56	0.48	7.08	15.97	12.08	3.89
1980	(1.00)	(2.96)	1.96	13.46	10.23	3.23
1979	3.69	(0.86)	4.55	12.07	9.13	2.94
1978	7.57	(1.11)	8.68	10.92	8.11	2.81
Arithmetic Average:						
1978-88	12.48	10.62	1.86	14.31	10.45	3.86
Compound Average:						
1978-88	12.10	9.69	2.41			

Notes:

[1]Merrill Lynch High-Yield Index for 1988. Altman's compilation of composite for 1978-83 generated from over 440 high-yield issues. Actual portfolio ranged in size from 153 issues in 1978 to 339 issues in 1983. This database goes through March 31, 1984; composite of several indices for 1985-87.

[2]Shearson Lehman Long-Term Government Index.

[3]Promised yield as of beginning of year. It represents the internal rate of return based on the security's current price and scheduled payments of interest and principal.

aside adequate reserves for these losses, it becomes more problematic for longer-term assessment, especially if the inputs are possibly biased.

It could be argued that both the numerator (calendar-year defaults) and denominator (amount of bonds outstanding) are subject to change in the future. If, for example, the amount of bonds outstanding, particularly those comprising the high-yield junk bond sector, falls or does not grow as it has in the past, then the default rate would increase, especially during a recessionary period. A recent working paper (Asquith, Mullins, and Wolff 1988) makes this point about the traditional method. We maintain that investors can estimate fairly precisely the loss reserves based on recent average loss experience, especially for the next year or two. Longer-term estimates may require a different perspective.

Another problem with the traditional method is that bonds are aggregated across all bond ratings to calculate the total corporate default rate (Table 2) or across the non-investment-grade, low-rated categories to calculate the high-yield bond default rate and losses (Tables 1 and 3). In some cases, it might be more appropriate to analyze bond performance in a less aggregated way, that is, across individual credit-quality classes such as bond ratings. Our proposed mortality rate technique is constructed to exploit this more disaggregated structure as well as to assess longer-term performance.

4. The Mortality Rate Concept

We retain the notion that default rates for individual periods—yearly, for example—are measured on the basis of defaults in the period in relation to some base population in that same period. The calculation becomes more complex, however, when we begin with a specific cohort group, such as a bond-rating category, and track that group's performance for multiple time periods. Because the original population can change over time as a result of a number of different events, we consider mortalities in relation to a survival population and then input the defaults to calculate mortality rates. Bonds may exit from the original population through at least four different events: defaults, calls, sinking funds, and maturities.[1]

The individual mortality rate for each year (marginal mortality rate = MMR) is calculated by

$$MMR_t = \frac{\text{Total Value of Defaulting Debt in the Year (t)}}{\text{Total Value of the Population of Bonds at the Start of the Year (t)}}$$

We then measure the cumulative mortality rate (CMR) over a specific period (1, 2, . . ., T years) by subtracting the product of the surviving populations of each of the previous years from one (1.0)

$$CMR_T = 1 - \prod_{t=1}^{T} SR_t$$

where

CMR_T = cumulative mortality rate in (T), and

SR_t = survival rate in (t) or $1 - MMR_t$

[1]There might be other "terminal" dates such as defeasance, but they have not been included in this analysis.

The examples in Tables 5 and 6, not based on actual data, illustrate calculations of the marginal and cumulative mortality rates. The calculations are for a specific year's cohort group—for example, BB-rated bonds issued in 1981 for one year and two years after issuance (Table 5), and for the same cohort group based on new issues for the period 1981-84 (Table 6). The resulting CMR is 1.00 percent for one year after issuance and 4.40 percent for two years.[2] The two-year cumulative mortality rate is calculated by

$$1 - (0.9900 \times 0.9657) = 4.40 \text{ percent.}$$

Note that the mortality rate is a value-weighted rate in the particular year after issuance, rather than an unweighted average. If we were simply to average each of the year-one rates in Table 6, our results would be susceptible to significant specific-year bias. If, for example, the amount of new issues is very small and the defaults emanating from that year are high in relation to the amount issued, the unweighted average could be improperly affected. Our weighted-average technique correctly biases the results toward the larger-issue years, especially the more recent years.

[2]Note that by simply adding the individual year marginal mortalities the result is virtually the same (4.43 percent). This will be the case for relatively low marginal mortalities in the earlier years, with the differential increasing in later years, especially as defaults and redemptions increase.

TABLE 5

Mortality Rate Concept (Illustrative Calculation) for BB-Rated Issues (1981)

Security No.	Issued Amount	Year 1 Default	Year 1 Call	Year 1 SF	Year 2 Default	Year 2 Call	Year 2 SF
1	50	—	—	5	—	—	5
2	50	50	—	—	NE	NE	NE
3	100	—	100	—	NE	NE	NE
4	100	—	—	—	100	—	—
5	150	—	—	—	—	—	15
6	150	—	—	—	—	—	—
7	200	—	—	20	—	—	20
8	200	—	—	—	—	200	—
9	250	—	—	—	—	—	—
10	250	—	—	—	—	—	—
Total	1,500	50	100	25	100	200	40

Amount Start of Period	1,500	–	175	=	1,325	–	340	=	985

	Year 1	Year 2
Period Mortality Rate	50/1500 = 3.3%	100/1,325 = 7.5%

Notes: NE = No longer in existence

SF = Sinking fund

TABLE 6

Mortality Rate Concept

	Year 1		Year 2	
1981 (BB)				
Amount Defaulted / Amount Outstanding	50 / 1,500	= 3.3%	100 / 1,325	= 7.5%
1982 (BB)				
Amount Defaulted / Amount Outstanding	0 / 3,000	= 0.0%	150 / 2,500	= 6.0%
1983 (BB)				
Amount Defaulted / Amount Outstanding	150 / 5,000	= 3.0%	150 / 3,675	= 4.1%
1984 (BB)				
Amount Defaulted / Amount Outstanding	0 / 10,500	= 0.0%	200 / 10,000	= 2.0%

Summary of Results

	Year 1		Year 2	
Marginal Mortality Rate	200 / 20,000	= 1.00%	600 / 17,500	= 3.43%
Cumulative Mortality Rate		= 1.00%		= 4.40%

5. Empirical Results

The total amount of new issues of corporate bonds between 1971 and 1988 is provided in Table 7, which lists the dollar amount, by bond rating, issued for the period according to statistics compiled from *Standard & Poor's Bond Guide.*[1] Investment-grade categories dominated new listings over much of the sample period. During the 1971-81 period, in the high-yield sector, BB issues showed small, relatively consistent issuance ranging from a low of $20 million in 1975 to a high of $579 million in 1977. Since 1982, however, new BB issues exceeded $1 billion each year. Single-B debt had small, sporadic new issuance from 1971-76. Since 1977, volume has increased, with more than $500 million issued in 1977; over $1 billion issued in 1978; about $6 billion in 1984 and 1985; and over $17 billion from 1986 through 1988. The number of issues for low-grade securities since 1977 is also listed. There were no more than 50 issues in total from 1977 to 1982, increasing to 100 or more from 1984 to 1988.[2]

Non-rated debt was not included in our formal analysis because the riskiness of those issues appears to have shifted over the years, with the most recent data probably dominated by low-rated equivalent securities. The earlier non-rated debt data appear to have included all risk types.

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[1]For a comparison with data compiled from Moody's, see Wilson (1987: 10).

[2]Note that the number of issues listed in Table 7 for low-grade bonds does not equal our prior high-yield computations (Altman and Nammacher 1987). This is because of the non-listing in Table 7 of split-rated BBB/Ba and non-rated issues. For example, in 1984, these other issues brought the total new issues to 124.

TABLE 7

Corporate Bond Total New Issue Amounts by S&P Bond Rating 1971-88 ($ million)

Bond Rating	1971	1972	1973	1974	1975	1976	1977	1978	1979
AAA	5,125	3,179	4,046	7,420	11,348	9,907	11,046	7,967	10,400
AA	5,467	4,332	3,670	8,797	9,654	9,560	7,494	7,374	5,910
A	6,688	4,745	4,254	8,388	12,752	8,103	5,236	5,330	6,489
BBB	2,139	1,198	937	1,248	2,367	2,938	1,558	1,513	1,225
BB	292	258	105	250	20	397	579	408	359
						(10)	(15)	(10)	(8)
B	112	101	140	18	27	59	526	1,029	917
						(3)	(17)	(39)	(33)
CCC	0	0	0	0	14	75	78	34	91
						(1)	(5)	(1)	(3)
Total Rated	19,823	13,813	13,152	26,121	36,182	31,026	26,485	23,606	25,350

Bond Rating	1980	1981	1982	1983	1984	1985	1986	1987	1988
AAA	10,109	11,835	6,197	3,920	2,350	9,016	14,438	10,540	18,540
AA	10,497	11,748	14,597	14,110	18,291	23,223	46,978	30,880	19,280
A	12,195	12,432	13,315	5,516	12,252	23,381	34,173	23,200	30,190
BBB	2,595	3,900	5,738	5,827	5,194	11,068	21,993	16,240	19,450
BB	418	290	1,378	2,894	4,698	2,041	7,098	5,000	2,570
	(9)	(6)	(16)	(24)	(23)	(23)	(37)	(31)	(13)
B	879	894	1,122	3,713	6,485	5,945	21,260	17,830	18,170
	(28)	(15)	(24)	(46)	(68)	(77)	(133)	(109)	(102)
CCC	25	0	145	285	1,901	1,668	4,668	4,620	5,640
	(1)	(0)	(2)	(5)	(9)	(14)	(40)	(23)	(36)
Total Rated	36,681	41,078	42,452	36,195	51,080	76,242	150,438	108,170	113,725

Note: Number of issues of low-rated bonds in parentheses.

Source: S&P Bond Guides

Mortality Rates

The data in Table 8 include our mortality rate computations, adjusted for redemptions and defaults, for the entire period 1971-88. The data include individual-year and cumulative mortalities for up to 10 years after issuance. It is possible to list the data beyond 10 years, but the number of observations diminishes as the number of years after issuance increases.[3]

The relative results across cohort groups are about as expected, with the mortality rates very low for the higher-rated bonds and increasing for lower-rated issues. For example, AAA-rated debt had a zero mortality rate for the first five years after issuance, then only 0.15 percent in year six, and 0.21 percent after 10 years (because of the 1987 Texaco bond default). AA-rated and A-rated debt reached just 2.42 percent and 1.13 percent, respectively, over a 10-year period.[4] The mortality rates begin to increase almost immediately after issuance for BBB- and lower-rated bonds, with BBB (the lowest investment-grade debt level) showing a cumulative rate of 1.00 percent after five years and 2.13 percent after 10 years.

The relatively high single-B mortality rates throughout the period and particularly in the later years—for example, 30.88 percent after 10 years—were somewhat unexpected. The single-B-rated debt, however, had relatively small issue amounts throughout the 1970s, so when the mortality rates are calculated for 10 years after issuance, the number of observations is quite small. For example, issue years 1971-78 are the only ones contributing to our 10-year results, 1971-79 to nine-year results, and so on. Hence, the longer-term mortality results should be analyzed with considerable caution with respect to expectations about future mortality rates and return spreads. As we will show, despite the high cumulative mortality rate, the net return to investors in B-rated bonds is still very attractive.

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[3]These data are available from the author. Only results for five years for CCC-rated debt were included because new issues in this category were essentially non-existent prior to 1982.

[4]In a preliminary version of this paper (Altman 1988), with default data only through 1986, the AAA default rate was zero for the entire sample period, with AA- and A-rated debt only registering 0.23 percent and 0.26 percent, respectively. The relatively large difference in these results compared with those in Table 8 is caused by the Texaco defaults in 1987, which have since been cured. In Table 8a we list the cumulative mortality rates based on default data through 1987. One can therefore compare results based on one additional year's data. Note that the results in Table 8 and 8a are quite similar.

TABLE 8

Adjusted Mortality Rates by Original S&P Bond Rating Covering Defaults and Issues from 1971-88 (In Percent)

	Years after Issuance									
	1	2	3	4	5	6	7	8	9	10
Original Rating										
AAA										
Yearly	0.00	0.00	0.00	0.00	0.00	0.15	0.05	0.00	0.00	0.00
Cumulative	0.00	0.00	0.00	0.00	0.00	0.15	0.21	0.21	0.21	0.21
AA										
Yearly	0.00	0.00	1.39	0.33	0.20	0.00	0.27	0.00	0.11	0.13
Cumulative	0.00	0.00	1.39	1.72	1.92	1.92	2.18	2.18	2.29	2.42
A										
Yearly	0.00	0.39	0.32	0.00	0.00	0.11	0.11	0.07	0.13	0.00
Cumulative	0.00	0.39	0.71	0.71	0.71	0.82	0.93	1.00	1.13	1.13
BBB										
Yearly	0.03	0.20	0.12	0.26	0.39	0.00	0.14	0.00	0.21	0.80
Cumulative	0.03	0.23	0.35	0.61	1.00	1.00	1.14	1.14	1.34	2.13
BB										
Yearly	0.00	0.50	0.57	0.26	0.53	2.79	3.03	0.00	0.00	3.48
Cumulative	0.00	0.50	1.07	1.34	1.86	4.59	7.48	7.48	7.48	10.70
B										
Yearly	1.40	0.65	2.73	3.70	3.59	3.86	6.30	3.31	6.84	3.70
Cumulative	1.40	2.04	4.72	8.24	11.54	14.95	20.31	22.95	28.22	30.88
CCC										
Yearly	1.97	1.88	4.37	16.35	2.06	N/A	N/A	N/A	N/A	N/A
Cumulative	1.97	3.81	8.01	23.05	24.64	N/A	N/A	N/A	N/A	N/A

Note: Mortality rates have been adjusted for changes in population (cohort groups) because of defaults, calls, and sinking fund redemption.

TABLE 8a

Adjusted Mortality Rates by Originial S&P Bond Rating Covering Defaults and Issues from 1971-87 (In Percent)

	Years After Issuance									
	1	2	3	4	5	6	7	8	9	10
Original Rating										
AAA										
Yearly	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00
Cumulative	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.13	0.13	0.13
AA										
Yearly	0.00	0.00	1.81	0.39	0.14	0.00	0.00	0.00	0.13	0.00
Cumulative	0.00	0.00	1.81	2.20	2.33	2.33	2.33	2.33	2.46	2.46
A										
Yearly	0.00	0.31	0.39	0.00	0.00	0.06	0.12	0.00	0.04	0.00
Cumulative	0.00	0.31	0.71	0.71	0.71	0.77	0.89	0.89	0.93	0.93
BBB										
Yearly	0.04	0.25	0.17	0.00	0.45	0.00	0.17	0.00	0.23	0.84
Cumulative	0.04	0.29	0.46	0.46	0.91	0.91	1.07	1.07	1.30	2.12
BB										
Yearly	0.00	0.62	0.64	0.31	0.29	4.88	0.00	0.00	0.00	0.00
Cumulative	0.00	0.62	1.25	1.56	1.84	6.64	6.64	6.64	6.64	6.64
B										
Yearly	1.98	0.92	0.74	4.24	4.16	4.98	3.62	4.03	8.47	4.33
Cumulative	1.98	2.88	3.60	7.69	11.53	15.94	18.98	22.24	28.83	31.91
CCC										
Yearly	2.99	2.88	3.97	22.87	1.37	N/A	N/A	N/A	N/A	N/A
Cumulative	2.99	5.87	9.52	30.22	31.17	N/A	N/A	N/A	N/A	N/A

Note: Mortality rates have been adjusted for changes in population (cohort groups) because of defaults, calls, and sinking fund redemption.

There are more observations for calculations up to five years after issuance, but data are still lacking for new issues in the most recent, high-growth years (1983-88). The five-year cumulative rate of 11.5 percent for B-rated debt might be considered surprisingly high. Consider, however, that the average annual default rate calculated in the traditional way is 1.92 percent per year for the period 1978-88 (Table 1). If we simply sum the one-year rates, the result is 9.60 percent for five years, compared with our CMR of 11.5 percent. In addition, the traditional default rates are calculated on the basis of the population on June 30 (Table 1), whereas our mortality rates use survival population data from the start of each year. Therefore, the traditional method understates default rates somewhat, at least with respect to the reference population date. As for the six-to-ten-year results, only time will tell if the relatively large marginal one-year rates, especially for the ninth year, continue in the future.

If we begin our analysis in 1976, rather than in 1971, the five-year B-rated cumulative rate is slightly higher at 11.7 percent, the eight-year rate is 23.7 percent, and the 10-year rate is 36.4 percent. The latter is caused by the relatively high nine- and ten-year default rates for 1977 new issues ($85.5 million and $26.7 million, respectively, from the $526 million issued).

The mortality results listed in Tables 8 and 8a are adjusted for redemptions, including calls and sinking funds, as well as for defaults. Although the procedures of adjusting each year for population changes in our cohort groups is consistent with the mortality (survival) concept, the results are not, strictly speaking, the proportion of the original population that have defaulted. Table 9 lists the unadjusted results, which are more consistent with the interpretation of original proportion default rates. The results are almost identical, especially in the earlier years after issuance. Hence, despite reasonably high call rates on certain bonds in later years, the mortality rates are not affected very much because of the combined effects of the mathematical cumulative rate calculation and the smaller population numbers as the population ages and redemptions increase. Our rates would be higher if, instead of mortality rate calculations, we simply assessed the proportion of the original population that defaults over time. But the latter number, although interesting, cannot be used for the compound net return calculations that we will ultimately measure.

TABLE 9

Unadjusted Mortality Rates by Originial S&P Bond Rating Covering Defaults and Issues from 1971-88 (In Percent)

	Years after Issuance									
	1	2	3	4	5	6	7	8	9	10
Original Rating										
AAA										
Yearly	0.00	0.00	0.00	0.00	0.00	0.15	0.05	0.00	0.00	0.00
Cumulative	0.00	0.00	0.00	0.00	0.00	0.15	0.20	0.20	0.20	0.20
AA										
Yearly	0.00	0.00	1.39	0.33	0.20	0.00	0.25	0.00	0.10	0.12
Cumulative	0.00	0.00	1.39	1.72	1.92	1.92	2.17	2.17	2.27	2.39
A										
Yearly	0.00	0.39	0.32	0.00	0.00	0.10	0.10	0.06	0.11	0.00
Cumulative	0.00	0.39	0.71	0.71	0.71	0.81	0.91	0.97	1.08	1.08
BBB										
Yearly	0.03	0.20	0.12	0.25	0.38	0.00	0.11	0.00	0.17	0.67
Cumulative	0.03	0.23	0.35	0.60	0.98	0.98	1.09	1.09	1.26	1.93
BB										
Yearly	0.00	0.50	0.57	0.25	0.49	2.47	2.26	0.00	0.00	2.72
Cumulative	0.00	0.50	1.08	1.33	1.82	4.29	6.55	6.55	6.55	9.27
B										
Yearly	1.40	0.64	2.68	3.47	3.32	3.28	4.39	2.40	4.02	1.76
Cumulative	1.40	2.04	4.72	8.19	11.51	14.79	19.18	21.58	25.60	27.36
CCC										
Yearly	1.97	1.88	4.29	16.13	1.97	N/A	N/A	N/A	N/A	N/A
Cumulative	1.97	3.84	8.13	24.26	26.23	N/A	N/A	N/A	N/A	N/A

Note: Mortality rates are unadjusted for all redemptions except defaults.

Losses

As in the previous discussion on traditional default measures, the loss to investors from defaults is of paramount importance. Table 10 lists the cumulative mortality losses on the population of bonds used to calculate mortality rates. We utilized actual recovery amounts on each default and factored in the lost interest coupon. The average recovery rate was slightly below 40 percent of par. Table 11 shows the losses incurred on the un-adjusted data corresponding to the unadjusted mortality rates listed in Table 9.

Losses Versus Original Ratings and Versus Time To Default

We found no essential relation between individual bond ratings at issuance and the subsequent average price that could be realized upon default. Table 12 lists the results for 222 defaulting issues and shows that the average retention rate was actually 43.2 percent including Texaco and 38.8 percent without Texaco. There is virtually no correlation between initial bond rating and the average price after default, with the exception of the AAA and AA ratings—again the Texaco phenomenon.

There also does not appear to be a correlation between the price after default and the number of years that a bond is in existence before default (Table 13). Although some evidence indicates that aging does affect default rates, there is no similar pattern to recoveries over time.

Net Return Performance

An important dimension of our analysis is the ability to track the performance of bonds from issuance, across bond ratings, and over relevant time horizons. This analysis enables us to compare the performance of various risky bond categories with default-free U.S. Treasury securities. By factoring into the analysis *actual* losses from defaults and yield spreads over Treasuries, we obtain a more complete analysis. We calculate actual return-spread performance, but the algorithm used is sufficiently robust to handle any set of assumptions on the variables analyzed. Note, however, that we do not use acutal prices on each bond in this computation.

Tables 14 and 15 and Figure 1 present the return spread results across bond ratings over the sample period 1971-88. The spreads, expressed in terms of dollars per $100 of investment (Table 14, through 1987) and basis points (Table 15, through 1988), are compounded over a 10-year investment horizon and are based on actual yield spreads (Table 16 and Figure 2) for the sample

TABLE 10

Mortality Losses by Original S&P Bond Rating Covering Defaults and Issues from 1971-88 (In Percent)

	Years after Issuance									
	1	2	3	4	5	6	7	8	9	10
Original Rating										
AAA										
Yearly	0.00	0.00	0.00	0.00	0.00	0.06	0.04	0.00	0.00	0.00
Cumulative	0.00	0.00	0.00	0.00	0.00	0.06	0.10	0.10	0.10	0.10
AA										
Yearly	0.00	0.00	0.21	0.11	0.03	0.00	0.20	0.00	0.07	0.10
Cumulative	0.00	0.00	0.21	0.32	0.35	0.35	0.55	0.55	0.62	0.72
A										
Yearly	0.00	0.08	0.06	0.00	0.00	0.05	0.06	0.02	0.06	0.00
Cumulative	0.00	0.08	0.14	0.14	0.14	0.19	0.25	0.27	0.33	0.33
BBB										
Yearly	0.02	0.12	0.08	0.17	0.27	0.00	0.11	0.00	0.11	0.38
Cumulative	0.02	0.14	0.22	0.39	0.66	0.66	0.77	0.77	0.88	1.26
BB										
Yearly	0.00	0.34	0.36	0.19	0.33	1.81	2.01	0.00	0.00	2.15
Cumulative	0.00	0.34	0.70	0.89	1.22	3.04	5.05	5.05	5.05	7.20
B										
Yearly	0.56	0.45	2.03	2.66	2.24	2.38	3.99	2.45	5.75	2.41
Cumulative	0.56	1.00	3.03	5.70	7.93	10.31	14.30	16.76	22.51	24.92
CCC										
Yearly	1.51	0.35	1.84	11.31	1.48	N/A	N/A	N/A	N/A	N/A
Cumulative	1.51	1.87	3.70	15.02	16.49	N/A	N/A	N/A	N/A	N/A

TABLE 11

Unadjusted Mortality Losses by Orginial S&P Bond Rating Covering Defaults and Issues from 1971-88

	Years after Issuance									
	1	2	3	4	5	6	7	8	9	10
Original Rating										
AAA										
Yearly	0.00	0.00	0.00	0.00	0.00	0.06	0.04	0.00	0.00	0.00
Cumulative	0.00	0.00	0.00	0.00	0.00	0.06	0.10	0.10	0.10	0.10
AA										
Yearly	0.00	0.00	0.21	0.11	0.03	0.00	0.19	0.00	0.06	0.09
Cumulative	0.00	0.00	0.21	0.32	0.35	0.35	0.54	0.54	0.60	0.69
A										
Yearly	0.00	0.08	0.06	0.00	0.00	0.04	0.06	0.02	0.05	0.00
Cumulative	0.00	0.08	0.14	0.14	0.14	0.18	0.24	0.26	0.31	0.31
BBB										
Yearly	0.02	0.12	0.08	0.16	0.26	0.00	0.09	0.00	0.09	0.32
Cumulative	0.02	0.14	0.22	0.38	0.64	0.64	0.73	0.73	0.82	1.14
BB										
Yearly	0.00	0.34	0.36	0.18	0.31	1.61	1.50	0.00	0.00	1.68
Cumulative	0.00	0.34	0.70	0.88	1.19	2.80	4.30	4.30	4.30	5.98
B										
Yearly	0.56	0.44	1.99	2.50	2.07	2.02	2.78	1.78	3.38	1.14
Cumulative	0.56	1.00	2.99	5.49	7.55	9.57	12.36	14.14	17.52	18.66
CCC										
Yearly	1.51	0.35	1.80	11.16	1.41	N/A	N/A	N/A	N/A	N/A
Cumulative	1.51	1.87	3.67	14.83	16.24	N/A	N/A	N/A	N/A	N/A

TABLE 12

Average Price After Default by Original Bond Rating

Original Rating	Average Price after Default (Per $100)	Number of Observations
AAA	65.48	7
AA	63.88	21
A	54.11	27
BBB	45.08	23
BB	36.03	20
B	40.09	81
CCC	42.80	16
C	10.00	2
NR	31.18	25
Average	43.18	222

TABLE 13

Average Price After Default by Number of Years After Issuance

Number of Years after Issuance	Average Price after Default (Per $100)	Number of Observations
<1	45.41	10
1-2	44.74	19
2-3	57.06	36
3-4	40.08	23
4-5	42.75	24
5-6	45.50	19
6-7	41.01	21
7-8	37.17	6
8-9	41.42	8
9-10	42.30	11
>10	43.94	42

TABLE 14

Realized Return Spread On Net Investment in Corporate Bonds Over Risk-Free Government Bonds* (1971-87)

Years after Issuance	Bond Rating at Issuance						
	AAA	AA	A	BBB	BB	B	CCC
0.5	$0.2155	$0.3620	$0.4950	$0.8154	$1.5315	$1.7936	$2.4390
1.0	0.4523	0.7603	1.0403	1.7162	3.2550	3.8167	5.1961
1.5	0.7120	1.1977	1.6097	2.6409	4.9506	6.0777	8.2814
2.0	0.9963	1.6770	2.2341	3.6573	6.8430	8.6124	11.7368
2.5	1.3090	2.0360	2.9221	4.8157	8.9505	11.4422	15.9351
3.0	1.6507	2.4268	3.6752	6.0871	11.2921	14.5991	20.6210
3.5	2.0374	2.9847	4.5748	7.5877	14.0457	15.9729	12.9234
4.0	2.4592	3.5936	5.5587	9.2331	17.0986	17.4559	4.9527
4.5	2.9265	4.3388	6.6381	10.7951	20.4670	19.4456	9.9969
5.0	3.4356	5.1523	7.8168	12.4993	24.1881	21.6072	15.6120
5.5	3.9807	6.0854	9.0861	14.6474	25.3096	24.0783	—
6.0	4.5738	7.1038	10.4700	16.9969	26.4822	26.7598	—
6.5	5.2453	8.2436	11.9970	19.5101	30.9498	30.0632	—
7.0	5.9761	9.4873	13.6612	22.2550	35.8497	33.6515	—
7.5	6.8111	10.9064	15.6317	25.5287	41.2942	36.9866	—
8.0	7.7202	12.4552	17.7824	29.1107	47.2477	40.5821	—
8.5	8.7495	14.1108	20.1755	32.9809	53.7049	38.7614	—
9.0	9.8703	15.9149	22.7864	37.2095	60.7230	36.7368	—
9.5	11.1059	18.0053	25.6894	41.3121	68.2443	40.5648	—
10.0	12.4493	20.2830	28.8525	45.7678	76.3715	44.6687	—
Average Yield Spread	0.471%	0.805%	1.085%	1.771%	3.049%	4.093%	7.070%

Notes: *Net investment adjusted for cumulative mortality rates, calls, and sinking fund redemptions. Assume sale of defaulted debt at the average price at the end of the month after default, plus loss of one coupon payment. Actual average YTM used for both Government and corporate bond returns. Returns are expressed in dollars per $100 of investment and assume an initial Government bond rate of 8.75 percent.

TABLE 15

Return Spreads Earned by Corporate Bonds Over Treasury Bonds (Measured in Basis Points Compounded Over Time) (1971-88)

Years after Issuance	Bond Rating at Issuance						
	AAA	AA	A	BBB	BB	B	CCC
1	45	76	105	171	313	370	572
2	100	169	222	367	666	849	1,421
3	165	254	369	614	1,097	1,225	2,312
4	246	373	558	901	1,653	1,583	1,899
5	343	529	786	1,229	2,289	2,077	3,083
6	447	725	1,051	1,671	2,714	2,589	N/A
7	578	924	1,370	2,190	3,164	2,838	N/A
8	747	1,215	1,775	2,856	4,316	3,515	N/A
9	954	1,554	2,259	3,641	5,639	3,421	N/A
10	1,201	1,949	2,853	4,493	6,233	4,215	N/A

period. The average yield spreads (Table 14) were 0.47 percent (AAA), 0.81 percent (AA), 1.09 percent (A), 1.77 percent (BBB), 3.05 percent (BB), 4.09 percent (B), and 7.07 percent (CCC).

The body of Table 14 represents returns realized above what would have been earned on risk-free Treasuries, measured at semi-annual intervals to conform with coupon payments. Table 15 presents results annually. Both use actual long-term Treasury coupon rates, yield spreads at birth for the different rating categories, the sale of defaulted debt, the loss of one coupon payment, and the reinvestment of cash flows at the then-prevailing interest rates for that bond-rating group. Cash flows are reinvested at the prevailing rates (Table 16 and Figure 2) in the same bond-rating category from coupon payments on the surviving population as well as the reinvestment of sinking funds, calls, and the recovery from defaulted debt. The results assume no capital gains or losses over the measurement period, and the investor follows a buy-and-hold strategy for the various horizons.

Results from Table 15 and Figure 1 show that AAA-rated bonds may be expected to earn 45 basis points ($0.45 per $100) *more than* Treasuries over one year (two semi-annual coupon payments) and 1,201 basis points ($12.01)

FIGURE 1

Realized Return Spread on Net Investment in Corporate Bonds Over Risk-Free Government Bonds

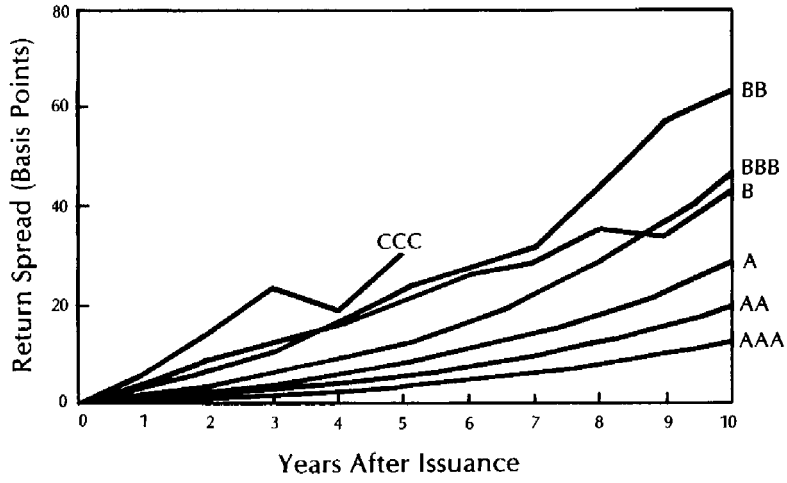
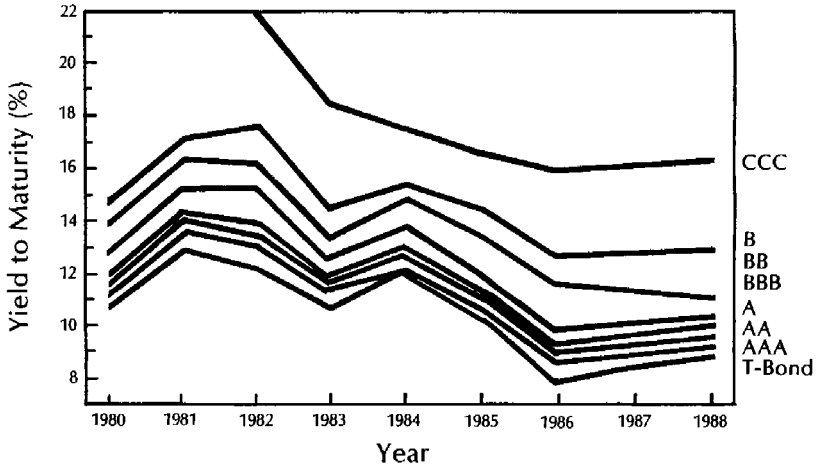


FIGURE 2

Yield to Maturity: Long-Term Corporate and Government Bonds (1980-88)



Note: Annual yield is the average for the 12 month period.

TABLE 16

Yield To Maturity on Various Bond-Rating Categories: 1973-88

Year	T. Bond	AAA	AA	A	BBB	BB	B	CCC
1973	7.15	7.56	7.71	7.87	8.40	NR	NR	NR
1974	8.13	8.33	8.56	8.65	9.37	NR	NR	NR
1975	8.28	8.64	8.89	9.31	10.12	NR	NR	NR
1976	7.88	8.36	8.37	8.81	9.45	NR	NR	NR
1977	7.76	8.12	8.34	8.48	8.87	NR	NR	NR
1978	8.57	8.74	8.93	9.05	9.53	NR	NR	NR
1979	9.27	9.53	9.80	10.01	10.62	NR	NR	NR
1980	11.22	11.66	12.02	12.31	13.09	14.15	14.98	NR
1981	13.20	13.91	14.32	14.60	15.50	16.54	17.33	NR
1982	12.51	13.32	13.73	14.19	15.45	16.32	17.76	21.86
1983	11.09	11.66	11.86	12.17	12.79	13.63	14.61	18.62
1984	12.34	12.43	12.94	13.25	13.97	14.99	15.53	17.71
1985	10.74	10.94	11.41	11.66	12.16	13.65	14.52	16.75
1986	8.16	9.02	9.40	9.64	10.19	11.79	12.82	15.98
1987	8.76	9.32	9.66	9.92	10.42	11.46	12.96	16.12
1988	9.11	9.55	9.93	10.28	10.64	11.22	12.99	16.37

Notes: Each yield to maturity is an average for the 12-month rates.

NR indicates not relevant because of small samples and unreliable data.

after 10 years. Bonds rated BB earn 313 basis points ($3.13) more than Treasuries after one year and an impressive 6,233 basis points ($62.33) after 10 years.

For the first four years after issuance, the lower the bond rating the higher the net return spread, with triple-C- and single-B-rated bonds doing best. In the fifth year, the B-rated bonds drop off. After the fifth year, however, the BB-rated category begins to dominate while the B-rated bonds continue to lose ground. That crossover is illustrated in Figure 1. For all holding periods, all bond types do well and have positive spreads over Treasuries.

As indicated, the historical average yield spread of 4.09 percent for B-rated (Table 14) debt provides an ample cushion to compensate for losses, but the performance relative to other categories is inferior in the later years. This would change, however, if we adjusted our assumptions to market conditions in the period October 1987 to early 1988. For example, yield spreads on single-B-rated bonds jumped to over 5.5 percent at the end of October 1987. Under this assumption, the resulting net return spreads over Treasuries are higher for the lower-rated bonds, with B-rated debt dominating all others for the entire 10-year time frame. Table 17 shows the simulated net return spreads assuming yield spreads of 5.5 percent on single-B-rated debt and 7.0 percent on CCC-rated debt.

Break-even Analysis

Another way to analyze these results is to express performance in terms of the yield spread required to break even from investments in corporate bonds versus U.S. Treasuries. This relation is shown in Table 18. Note that the required yield spread to produce zero return spreads for each category is, in most cases, extremely small. For example, the required yield spread for AAA-rated bonds is actually zero for the first five-and-a-half years after issuance because the default loss was also zero over that period. Over 10 years, the required spreads are all very low, with the exception of B-rated bonds, which required a net yield spread of 2.45 percent—still significantly below the historical average of about 4 percent. CCC-rated bonds require sizeable yield spreads over the five-year horizon observed, with spreads as much as 5.9 percent for four years.

Again, we assume that either the bondholder received coupon payments over the holding period, redeemed the bonds at par and reinvested the proceeds, or sustained a default and could only reinvest the recovered amount.

TABLE 17

Expected Return Spread on Net Investment in Corporate Bonds Over Risk-Free Government Bonds

Years after Issuance	Bond Rating at Issuance						
	AAA	AA	A	BBB	BB	B	CCC
0.5	$0.250	$0.425	$0.625	$0.980	$1.500	$2.475	$0.890
1.0	0.522	0.889	1.309	2.056	3.154	5.227	1.866
1.5	0.819	1.395	2.055	3.129	4.630	7.898	3.491
2.0	1.141	1.945	2.868	4.301	6.245	10.845	5.276
2.5	1.491	2.543	3.754	5.630	8.083	14.673	6.269
3.0	1.869	3.191	4.715	7.079	10.090	18.902	7.344
3.5	2.279	3.855	5.759	8.752	12.393	20.641	12.448
4.0	2.722	4.573	6.891	10.572	14.903	22.501	18.151
4.5	3.200	5.391	8.116	12.276	17.645	26.662	23.572
5.0	3.715	6.275	9.440	14.120	20.627	31.206	29.566
5.5	4.271	7.228	10.834	16.413	21.956	34.216	—
6.0	4.869	8.256	12.338	18.897	23.362	37.444	—
6.5	5.512	9.363	13.918	21.475	27.243	42.965	—
7.0	6.203	10.554	15.619	24.259	31.460	48.971	—
7.5	6.945	11.834	17.538	27.384	36.040	53.761	—
8.0	7.742	13.210	19.603	30.757	41.009	58.906	—
8.5	8.596	14.592	21.795	34.214	46.394	60.701	—
9.0	9.511	16.072	24.149	37.935	52.226	62.542	—
9.5	10.491	17.762	26.707	41.363	58.537	69.266	—
10.0	11.540	19.573	29.453	45.031	65.360	76.516	—
Yield Spread	0.50%	0.85%	1.25%	2.00%	3.00%	5.50%	7.00%

Notes: Net investment adjusted for cumulative mortality rates, calls, and sinking fund redemptions. Assume sale of defaulted debt at 40 percent of par, plus loss of one coupon payment. Assumes coupon rate on Government bonds of 8.75 percent. Returns are expressed in dollars per $100 of investment.

TABLE 18

Required Yield Spread to Produce Zero Returns for Each Category of Bond for a Specific Holding Period (In Percent)

Years after Issuance	AAA	AA	A	BBB	BB	B	CCC
0.50	0.000	0.000	0.000	0.024	0.000	0.450	2.322
1.00	0.000	0.000	0.000	0.025	0.000	0.442	2.282
1.50	0.000	0.000	0.014	0.065	0.131	0.452	2.141
2.00	0.000	0.000	0.025	0.084	0.197	0.457	2.070
2.50	0.000	0.046	0.032	0.090	0.239	0.461	1.881
3.00	0.000	0.078	0.037	0.093	0.267	0.464	1.754
3.50	0.000	0.082	0.032	0.080	0.257	0.857	4.125
4.00	0.000	0.086	0.028	0.070	0.249	1.152	5.933
4.50	0.000	0.078	0.025	0.096	0.247	1.334	5.398
5.00	0.000	0.073	0.022	0.116	0.245	1.480	4.973
5.50	0.000	0.066	0.024	0.106	0.502	1.586	—
6.00	0.001	0.060	0.025	0.097	0.717	1.674	—
6.50	0.001	0.056	0.029	0.100	0.662	1.701	—
7.00	0.001	0.052	0.031	0.102	0.614	1.723	—
7.50	0.001	0.048	0.029	0.096	0.573	1.779	—
8.00	0.001	0.045	0.027	0.090	0.537	1.827	—
8.50	0.001	0.047	0.027	0.092	0.506	2.133	—
9.00	0.001	0.049	0.027	0.093	0.478	2.404	—
9.50	0.001	0.046	0.026	0.114	0.452	2.428	—
10.00	0.001	0.044	0.024	0.133	0.430	2.450	—

Note: The bond yield equivalent for Treasury bills is assumed to be 7.00 percent.

The analysis does not assume any credit-quality shifts, up or down, other than default. This may understate the actual required yield spread on some bonds, because downgrades and the consequent price deterioration are probable for AAA bonds. In fact, we do not have good estimates of the bond-rating "drift" over time, and in this study we do assume a buy-and-hold strategy.[5] If we were interested in finite rates of return on our various bond-rating classes, and marked the initial portfolio to market on a continuous basis, then bond-rating changes would be a factor.

[5]The author is presently studying the bond rating drift phenomenon under partial funding by the Research Foundation of the Institute of Chartered Financial Analysts.

6. Recent Default Studies

Asquith, Mullins, and Wolff Study and Related Studies

Because of its alleged dramatically different results, it is worthwhile to review a recent study by Asquith, Mullins, and Wolf (1988), hereafter denoted as AMW. AMW criticize the traditional method as outlined in Chapter 3 and argue that, because the high-yield market has been growing dramatically in recent years, if and when that growth diminishes and if defaults rise in a recessionary period, then the default rate will increase significantly. Also, they argue that the traditional method says nothing about the "aging" of bond issues over time. The authors propose tracking individual issues from particular years to assess the probability that a junk bond issue would default over time.

The cumulative default rate results of this aging approach were found to be about 34 percent for those issues coming to market in 1977 and 1978. The difference between AMW's study and this one lies in the use of cumulative mortality rates (the present study) and the aged rates (the AMW study). The rationale for using cumulative rates was also set forth in Chapter 3.[1] Indeed, the AMW results are essentially the same as our mortality results and not very different from the traditional approach. For example, an annual average default rate of 2.5 percent results in about a 30 percent rate over 12 years.

The mortality rate approach results are preferred to any other because they are much more all-encompassing. The focus of this study, for example, is on default losses, not default rates. For investors, this is the issue of interest. In a related study, Laurie Goodman (1989) used the AMW aging default rates to calculate net return spreads over Treasuries under various assumptions of

[1]It should be noted that our original mortality results, first published in February 1988, predated the AMW aged approach by almost a full year.

interest-rate spreads and recovery rates on defaulted debt. Her results are reproduced in Table 19. Under virtually every scenario, the net return spreads to the high-yield investor are positive and attractive. For example, assuming a 4 percent interest yield-to-maturity spread and a 40 percent recovery rate, the net spread to investors in junk bonds for the 1977-78 period would have been 223 basis points. Our results (Tables 13 and 14) show similarly attractive and significant return spreads for all corporate bond ratings, especially the lower-rated ones.

Blume and Keim Study

One could argue that most of the above studies utilize simulated results, to some degree, in order to estimate actual results. Asquith and others criticize simulations as not always realistic. In order to answer that critique, Blum and Keim (1989) took the Asquith 1977 and 1978 cohort groups and calculated actual returns. Their results show that investors in all newly issued high-yield "junk" bonds in 1977-78 still outperformed intermediate-term Treasuries by almost 1 percent per year over the sample period. The 8.51 percent actual yield earned by the 1977-78 cohorts was about 2.6 percent less than the promised yield. The comparable yield on intermediate-term Treasury bonds averaged 7.60 percent over the 1977-78 period. Intermediate-term T-bonds were used because the duration of these Government bonds is comparable to high-yield junk bonds.

Assuming cash flows for the actual 1977-78 high-yield bonds were reinvested in their own junk bond index, Blume and Keim calculated a total return of 10.37 percent and almost the same if reinvested in either high-grade corporates or long-term Treasury bonds. These results show positive return spreads for junk bonds. The Blume-Keim results answer the commonly heard critique of the Asquith, Mullins, and Wolff study's failure to measure returns on the 1977-78 newly issued junk bonds. The AMW study also presents results adjusted for calls and distressed exchange issues. AMW estimate that about one-third of the 1977-78 cohorts had defaulted or had been exchanged and another one-third had been called.[2]

[2]Because a large percentage of the exchanges eventually default, not including exchanges in our mortality rates does not materially affect our results.

TABLE 19

Spreads to Treasuries on a High-Yield Portfolio

Recovery Rate	300 Basis Points			400 Basis Points			500 Basis Points		
	1977	1978	Altman	1977	1978	Altman	1977	1978	Altman
				Call Scenario #1*					
0.25	1.12	0.16	0.44	2.20	1.18	1.46	3.27	2.19	2.48
0.30	1.26	0.36	0.61	2.33	1.37	1.63	3.40	2.38	2.65
0.35	1.39	0.55	0.79	2.46	1.57	1.81	3.52	2.58	2.83
0.40	1.52	0.74	0.96	2.59	1.76	1.98	3.64	2.77	3.00
0.45	1.66	0.94	1.14	2.71	1.95	2.15	3.76	2.96	3.17
0.50	1.78	1.12	1.31	2.83	2.14	2.32	3.88	3.15	3.34
0.55	1.91	1.32	1.48	2.95	2.33	2.50	4.00	3.34	3.51
0.60	2.04	1.51	1.65	3.08	2.52	2.67	4.11	3.53	3.68
0.65	2.16	1.70	1.83	3.19	2.70	2.83	4.23	3.71	3.84
				Call Scenario #2**					
0.25	0.71	-0.38	N/A	1.79	0.64	N/A	2.87	1.65	N/A
0.30	0.86	-0.16	N/A	1.94	0.86	N/A	3.02	1.87	N/A
0.35	1.06	-0.06	N/A	2.09	1.07	N/A	3.15	2.09	N/A
0.40	1.17	0.28	N/A	2.23	1.24	N/A	3.29	2.31	N/A
0.45	1.32	0.50	N/A	2.37	1.54	N/A	3.43	2.52	N/A
0.50	1.46	0.72	N/A	2.51	1.72	N/A	3.56	2.74	N/A
0.55	1.61	0.94	N/A	2.65	1.94	N/A	3.69	2.95	N/A
0.60	1.75	1.15	N/A	2.79	2.16	N/A	3.82	3.16	N/A
0.65	1.89	1.37	N/A	2.92	2.36	N/A	3.95	3.37	N/A
				Call Scenario #3***					
0.25	0.88	-0.09	0.18	1.96	0.93	1.20	3.04	1.95	2.23
0.30	1.02	0.11	0.37	2.10	1.13	1.39	3.17	2.15	2.41
0.35	1.16	0.32	0.56	2.23	1.34	1.57	3.30	2.35	2.59
0.40	1.31	0.53	0.74	2.37	1.54	1.76	3.43	2.55	2.77
0.45	1.45	0.73	0.93	2.50	1.74	1.94	3.56	2.75	2.95
0.50	1.59	0.93	1.11	2.63	1.94	2.12	3.68	2.95	3.13
0.55	1.72	1.13	1.29	2.76	2.14	2.30	3.81	3.15	3.31
0.60	1.86	1.33	1.47	2.89	2.34	2.48	3.93	3.34	3.49
0.65	1.99	1.53	1.65	3.02	2.53	2.66	4.05	3.53	3.66

Notes: * Call Scenario #1: Nothing called.

** Call Scenario #2: Actual amount called for these years (29.13 percent for 1977 and 23.09 percent for 1978). The call was assumed to have occurred in 1983, the first major dip in rates. The call price was assumed to be par. No calculations were done for the Altman default schedule, as it aggregated bonds originally issued in different years during 1971-77.

***Call Scenario #3: Actual amount called in 1977 and 1978. The amount called was assumed to be evenly distributed in the past five years. For Altman's bankruptcy schedule, a 25 percent call was used, assumed to be evenly distributed over the past five years. The call price was assumed to be par.

Source: Reprinted with permission from Laurie S. Goodman, "High Yield Default Rates: Is There Cause For Concern?" Goldman Sachs & Co. Fixed-Income Research, April 1989.

Moody's and DRI Studies

The continuous debate on the riskiness of junk bonds and the relationship of actual and perceived future risk with past and expected return performance has spawned two additional recent studies. Moody's studied the default frequency of rated corporate bond *issuers* from 1970 to 1988, relating the histories of over 3,000 debt issuers to their subsequent default and distress exchange experience. While the study, authored by Douglass and Lucas (1989), was initiated to assess the credit support needed for structured financings backed by corporate bond portfolios, it also generated a good deal of interest among practitioners on the level of risk of bonds. A second study by DRI/McGraw-Hill, commissioned by the Alliance for Capital Access, focused on the expected default and return experience given different assumptions about recessionary behavior of the economy, rather than on the past experience of corporate bonds. The researchers, Wyss, Probyn, and de Angelis (1989), analyzed whether higher yields on junk bonds justify the increased risks investors take in purchasing them.

The Moody's study was similar to our mortality work. Their sample period was identical and all bond rating categories were analyzed—of course, they used Moody's ratings in their study and we used Standard & Poor's ratings.[3] Both studies tracked the cumulative default experience over at least 10 years after issuance. There were some major differences as well between the studies because Moody's concentrated on the number of issuers, not the amount outstanding, and did not analyze the recovery rate on defaulted or exchanged issues. Therefore, it was not possible to assess rates of return on the bonds or any measure of overall performance. Also, the mortality concept adjusts the initial population over time for calls and sinking fund redemptions, whereas the Moody's study left the continuing population unadjusted. Moody's also included distressed exchange issues in their calculations; the mortality data does not. Although I agree that distressed exchanges are relevant to investor performance, the difference in results is probably not significant, as Asquith, et al. (1988) and others have found in their studies.

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[3]One could quarrel with the exact similarity of the two agencies' ratings, because we often find mixed or split ratings on the same issue. In an earlier work (Altman 1983), I found that almost 20 percent of the issues of electric public utilities had different ratings when comparing S&P with Moody's. Also, there are apparent differences between Moody's and S&P at the CCC vs. Caa level.

A major finding by Moody's was that of the 222 issuers with long-term ratings that defaulted on bonds during their 19-year sample period (1970-88), as documented earlier (Altman & Nammacher 1985), only one issue (Manville) was investment-grade at the time of default. Default frequency increased for progressively lower-rated issuers, with 4 percent of issuers rated Baa defaulting in 10 years, 14 percent for Ba issuers, and 29 percent for B-rated issuers. These statistics compare fairly closely with the mortality results in Table 8. The Moody's 10-year cumulative rate for all investment-grade issuers was 2 percent, and it was 17 percent for speculative, junk bond issuers. Finally, year-to-year variability in default rates was significantly greater for lower-rated issuers, and the study queries whether the higher volatility in rates implies lower predictability which "may help explain the higher-than-expected risk premiums that many market observers have noted for lower rated bonds."

Table 20 shows the similarities in the Moody's and mortality rate results; it also points out some conspicuous differences. The Aa/AA default rates are higher in the mortality rates study, no doubt because of the large Texaco defaulting issues which will cause the market-value-weighted mortality results to be higher than the equally rated Moody's findings. Other differences show

TABLE 20

Five- and Ten-Year Cumulative Default Rates: Moody's vs. Mortality Studies Results (1970-88)

Rating	Moody's Study 5-Year(%)	Moody's Study 10-Year(%)	Mortality Study 5-Year(%)	Mortality Study 10-Year(%)
Aaa/AAA[1]	0.2	0.8	0.0[1]	0.2
Aa/AA	0.5	1.4	1.9	2.4
A/A	0.5	1.4	0.7	1.1
Baa/BBB	1.6	3.7	1.0	2.1
Ba/BB	8.3	14.2	1.9	10.7
B/B	22.3	29.3	11.5	30.9

Note: [1]The first AAA default was recorded in the sixth year, giving 0.15 percent rate.

Sources: Historical Default Rates of Corporate Bond Issuers, 1970-1988 (Moody's Special Report, July 1989, Figures 8 and 9) and Table 8 of this study.

that the Ba/BB and B/B five-year rates are much higher for Moody's, although the results after 10 years are quite close. It is possible that Moody's is less likely to give its lowest non-default rating (Caa) to new-issue debt, while S&P's CCC rating was more in evidence. Because the CCC rating had very high default rates in the first five years (see Table 8), if these same bonds were originally rated in the B categories (perhaps B3) by Moody's, this would help explain that study's higher early default rate for B-rated debt. The inclusion of distressed exchanges might also contribute to these differences.

The DRI study examined a sample of 573 outstanding, original-issue, non-investment-grade bonds issued over the period 1977-88, under alternative economic scenarios. They projected cash flows and balance sheets for the individual issuers to estimate defaults under the following four economic scenarios: (1) a "soft-landing" downturn with no recession but rising prices; (2) a mild recession with a short, two-quarter drop in real GNP; (3) a big recession with a peak-to-trough decline in GNP of 3 percent and interest rates declining during the recession; and (4) an inflationary, major recession with interest rates increasing in spite of the weak economy. Using projections of individual industry performance, a model was developed to project the impact of each scenario on the 573 high-yield bond issuers.

Based on the default projections, risk-adjusted returns for high-yield bonds and nine other asset classes were simulated for the period 1989-93. The high-yield bond portfolio, despite higher default rates, outperforms all other major asset classes in each of the scenarios except the inflationary recession when the CDs and short-term Treasury bills do best because of rising interest rates. The DRI study "suggests that high-yield bonds are priced attractively enough to compensate for their higher risk of default."

As for defaults, the DRI study found that over the five-year period 1989-93, the cumulative default rate on all original issue high-yield bonds would be about 13 percent for the first three economic scenarios and almost 19 percent for the inflation-recession. These rates are similar to our cumulative mortality rate on B-rated debt for five years (11.5 percent). The DRI authors estimated that mortality rates would be 5 percent on fixed-rate mortgages and as much as 17 percent on variable-rate mortgages over this same five-year period. They caution that although the yields available on high-yield debt seem high enough to compensate for the increased risk of default in an inflation-recession period, this is so "as long as an investor is not forced to sell out the rest of the portfolio at the bottom of the market. . . ." (p. 7).

Based on their results, the DRI group suggests that there does not appear to be sufficient reason to restrict the ability of institutions to hold high-yield securities any more than other classes of risky assets. This is, in essence, what I suggested in an earlier editorial (Altman 1989).

7. Implications

This study provides data on expected mortality rates and losses, cumulated for a number of years after issuance, for various bond-rating categories. Despite somewhat high cumulative mortality rates for some rating classes over long holding periods, return spreads on all corporate bonds are positive, with impressive results for the high-yield categories. It is certainly feasible for the analyst to use higher- (or lower-) than-historic mortality rates to reflect a number of macro- and microeconomic uncertainties, or different yield-spread assumptions.

Why are such relatively consistent positive return spreads for all rating categories observed? Given our assumptions, the implication is that investors have been more than satisfactorily compensated for investing in high-risk securities. Indeed, if expected default losses are fully discounted in the prices (and yields) of securities and no other meaningful risks are evident, then our return-spread results should not differ significantly from zero. The fact that the spreads are so positive has a number of possible explanations, none of them easily corroborated.

One possible explanation is that the fixed-income market has been mispricing corporate issues in relation to *ex ante* versus *ex post* spreads and that the discrepancy has persisted, perhaps because of the lack of appropriate information. This implies market inefficiency, which is both hard to prove conclusively and not very satisfying to certain market theorists and practitioners. If, however, default losses are consistently lower than return spreads and this comparison is the only relevant determinant of future yield spreads, inefficiency is a reasonable conclusion.

If all other things are not equal for determining yield spreads on corporate bonds, the market inefficiency conclusion is difficult to obtain. For example, liquidity risk is often mentioned as being important to price determination. If liquidity risk increases with lower bond ratings, the excess returns noted earlier may, in part, be the returns necessary to bear the risk. Indeed, during the post-October 19, 1987 period, and in the full 1989 market decline, poor liquidity was cited as one cause of the precipitous drop in common-stock prices and the rise in yields of high-yield debt issues.

The other risk element that is not isolated in our study is reinvestment risk. Actual returns on bonds are obviously affected by interest-rate changes. Our results do assume actual reinvestment rates over time, but capital gains or losses are not factored into the net return spreads, nor are capital gains from credit-quality changes factored in. The price fluctuations perhaps have, in the past, clouded the effect of default losses and liquidity conditions on returns of high-risk bonds, especially on lower-quality issues.

Another explanation of the persistent positive return spreads attributed to lower-rated bonds is the variability of retention values after default. Our observation of a selling price at an average of approximately 40 percent of par value just after default is an expected value. Investors might require positive spreads based on the possibility that retention values will be below the 40 percent average. In addition, the 40 percent retention is relevant only for a portfolio of defaulting bonds. An investor may not be well diversified and may be vulnerable to higher-than-average mortality losses on specific issues. Therefore, if the market prices low-quality issues as individual investments and not as portfolios, required spreads are likely to be higher than necessary.

Investors might also be restricted to the risk class of possible investments, thereby creating an artificial barrier to supply-demand equilibrium. For instance, certain institutions are prohibited from investing in low-grade bonds or are limited in the amount that they may invest in such securities. This reduces demand and inflates yield and return spreads.

I believe this study enhances our understanding of fixed-income performance results and of expectations for risky securities. This will not be the last word in this area, however, nor should it be.

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