EDWARD I. ALTMAN*

Measuring Corporate Bond Mortality and Performance

1. Introduction

The recent emergence of the high yield corporate debt market in the United States has intensified interest 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 risk dimensions of investing in fixed-interest instruments, i.e., interest-rate risk and liquidity risk. The interaction among the three dimensions of risk has raised the analytic content of fixed-income assessment to an increasingly sophisticated level. The analysis of default risk, however, has probably been the area of most concern and empirical measurement over the years since the initial pioneering work by HICKMAN (1958).

The appropriate measure of default risk and the accuracy of its measurement is critical in the pricing of debt instruments, in the measurement of their performance, and in 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 rate of default has been 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 default rates are then usually compared with observed promised yield spreads in order to assess the attractiveness of particular bonds or classes of bonds. A corollary approach is to compare default rates with ex-post returns to assess whether investors were compensated for the risks they bear. This study seeks to explore further the notion of default risk by developing an alternative way of measuring that risk and utilizes this measure to assess the performance of fixed-income investment strategies over the entire spectrum of credit-quality classes. Our approach seeks to measure the expected mortality of bonds in a manner similar to that used by actuaries in assessing human mortality. Our use of the term mortality refers specifically to a life expectancy or survival rate for various periods of time after issuance. Although it is informative to measure default rates and losses based on the average annual rate method, that traditional technique has at least two deficiencies. It fails to consider that there are other ways in which a bond dies, namely redemptions from calls, sinking funds, and maturation. Therefore, it fails to consider the surviving population of bonds. Nor does it answer the question of the probability of default for various time periods in the future on the basis of an issue's specific attributes at issuance, summarized into its

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bond rating. This study does explicitly consider the surviving population as the relevant basis or denominator in the default calculation and addresses the initial default assessment by 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, 2 years, 3 years or N years?

(2) 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?

(3) Given estimates of cumulative mortality losses suffered by investors and expected return spreads earned on the surviving population of bonds, what were the net return spreads earned or lost in comparison with returns on risk-free securities?

This paper is organized as follows. In Section 2 we review prior studies in the default risk area. In Section 3 we expand on traditional measures of default rates and losses. The new concept of mortality rates is then presented in Section 4 indicating what we believe to be a more comprehensive and meaningful measure. Section 5 presents empirical results including new issue volume by bond rating, adjusted mortality rates and losses and finally, net returns spreads received by investors in different risk categories of bonds. The final section reviews the paper's implications.

2. Prior Studies

Previous works in the area of default were of three general kinds. The first example, which might be called HICKMAN-style (1958) reports, usually present statistics on annual default rates and actual returns to bondholders over various time frames.

A second kind of study emphasized the default risk potential of individual-company debt by examining the determinants of risk premiums over risk-free securities, e.g., FISHER (1959), or by constructing univariate (BEAVER, 1966) or multivariate classification models, ALTMAN (1968) and others, based on the combination of micro-finance measures and statistical classification techniques. 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 emphasizes the distinction between favorable and unfavorable disappearance. Our measure of mortality of bonds has similar qualities in that we adjust the population for various kinds of redemptions.

Finally, a study by FONS (1987) attempts to combine observed pricing and the inherent default risk premium with estimates of corporate bond default experience. He incorporates 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 of debt with no relevance for volatility or liquidity factors. FONS did not believe, however, that default rates on particular bond-rating classes could be meaningfully addressed because the ratings are not permanent designations. Yet, it does appear to be relevant to measure losses to investors by original investment in specific bond-rating categories.

3. Traditional Measures of Default Rates and Losses

The corporate debt market has pretty much accepted the distinction between the so-called investment-grade and non-investment grade categories. At the same time, bonds receive more precise ratings with four classes of investment-grade debt and essentially three classes of 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. Our own results in Table 1 show that the average annual default rate, measured in the traditional way, for the period 1978-1989 was 2.10 % per year [1].

3.1. Default Losses

The more relevant default statistic for investors is not the rate of default but the amount lost from defaults [2]. 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. The investor also is assumed to lose one coupon payment. The average annual default loss over the sample period has been approximately 1.5% per year. That lower percentage of loss compared with default rates stems from the fact that defaulting debt, on average, sells for approximately 40% of par at the end of the defaulting month, although the recovery rate in defaulted debt has been deteriorating in the last two years.

Table 1: Historical default rate - low rated, straight debt only (1970 - 1989, $ millions).

Year	Par Value Outstanding	Par Value Default	Default Rate
1989	201'000	8'100.00	4.035%
1988	159'223	3'944.20	2.477%
1987	136'952	7'485.50*	5.466% *
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 1970 to 1989	2.485%
Average 1978 to 1989	2.095%
Average 1983 to 1989	2.706%

Notes:
* $1'841.7 million without Texaco, Inc., Texaco Capital, and Texaco Capital N.V. The default rate without these is 1.345%.

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, however, becomes more complex 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 can exit from the original population by means of at least four different events: defaults; calls; sinking funds; and maturities.

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 time period (1, 2,...., T years) by subtracting the product of the surviving populations of each of the previous years from one, that is:

$$CMR_{(T)} = 1 - \prod_{t=1}^{T} SR_t$$

where ,
$CMR_{(T)}$ = cumulative mortality rate in (T)
$SR_{(t)}$ = survival rate in (t) = 1 - $MMR_{(t)}$

The individual year marginal mortality rates for each bond rating are based on a compilation of that year's mortality measured from issuance. For example, all the one year mortalities are combined for the 17 year sample period to arrive at the one year rate, all the second year mortalities are combined to get the two year rate, etc.
The mortality rate is a value-weighted rate for the particular year after issuance, rather than an unweighted average. If we were to simply average each of the year one rates, year two rates, etc., 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.

5. Empirical Results

Table 2 lists the dollar amount, by bond rating, issued for the period 1971-1988 according to statistics compiled from Standard & Poor's Bond Guide. Note that investment-grade categories dominated new listings over much of the sample period. During the 1971-1981 period, the below investment grade sector showed small, relatively consistent BB-rated issues ranging from a low of $20 million in 1975 to a high of $579 million in 1977. Since 1982, however, BB new issues exceeded $1 billion each year. Single-B debt had small, sporadic new issues from 1971-1976. Since 1977, volume has picked up with more than $500 million issued in 1977; more than $1 billion issued in 1978; more than $6 billion in 1984-1985 and over $21 billion in 1986 [3]. The number of issues in each year is also indicated for the junk bond sector (lower three categories of ratings) since 1977, showing its impressive growth.

5.1. Mortality Rates

The data in Table 3 show our mortality rate computations, adjusted for redemptions and defaults, for the entire period 1971-1988. The data include cumulative mortalities for up to 10 years after issuance. It is possible to list the data for beyond 10 years but the number of observations obviously diminishes as the number of years after issuance increases.
The relative results across cohort groups are pretty much in line with expectations, 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 and then only 0.15% in year 6 and 0.21% for 10 years. AA-rated and A-rated debt mortalities reached just 2.42% and 1.13% respectively over a 10 year period. The mortality rates for BBB and lower bonds begin to increase almost immediately after issuance, with BBB (the lowest investment-grade debt level) showing a cumulative rate of 1.00% after five years and 2.13% after 10 years.
The single-B mortality rates were relatively high throughout the period and particularly in the later years. The marginal mortality rates are fairly constant after year three. The single-B-rated debt, however, had relatively small issue amounts throughout the 1970's, and when we calculate mortality

Table 2: Corporate bond total new issue amounts by S&P bond rating, 1971 - 1988 ($ million).

Bond Rating	1971	1972	1973	1974	1975	1976	1977	1978	1979
AAA	5125	3179	4046	7420	11348	9907	11046	7967	10400
AA	5467	4332	3670	8797	9654	9560	7494	7374	5910
A	6688	4745	4254	8388	12752	8103	5236	5330	6489
BBB	2139	1198	937	1248	2367	2938	1558	1513	1225
BB	292	258	105	250	20	397	579	408	359
						(10)	(15)	(10)	(8)
B	112	101	140	18	27	59	526	1029	917
						(3)	(17)	(39)	(33)
CCC	0	0	0	0	14	75	78	34	91
						(1)	(5)	(1)	(3)
Total Rated	19823	13813	13152	26121	36182	31026	26485	23606	25350

Bond Rating	1980	1981	1982	1983	1984	1985	1986	1987	1988
AAA	10109	11835	6197	3920	2350	9016	14438	10540	18540
AA	10497	11748	14597	14110	18291	23223	46978	30880	19280
A	12195	12432	13315	5516	12252	23381	34173	23200	30190
BBB	2595	3900	5738	5827	5194	11068	21993	16240	19450
BB	418	290	1378	2894	4698	2041	7098	5000	2570
	(9)	(6)	(16)	(24)	(23)	(23)	(37)	(31)	(13)
B	879	894	1122	3713	6485	5945	21260	17830	18170
	(28)	(15)	(24)	(46)	(68)	(77)	(133)	(109)	(102)
CCC	25	0	145	285	1901	1668	4668	4620	5640
	(1)	(0)	(2)	(5)	(9)	(14)	(40)	(23)	(36)
Total Rated	36681	41078	42452	36195	51080	76242	150438	108170	113725

Note:
Number of issues of low rated bonds in parentheses: from S&P Bond Guides.

rates for 7-10 years after issuance, the number of observations is quite small. For example, years 1971-1978 are the only years contributing to our 10-year results; 1971-1979 to nine-year results, and so on. Hence, we emphasize that the longer-term mortality results should be analyzed with considerable caution with respect to expectations about future mortality rates and return spreads [4]. Despite the high cumulative mortality rate,for single B's we will show that the net return to investors remains very attractive.

The results for five years after issuance do provide more observations, but they too lack results for new issues in the most recent, high-growth years (1983-1987). The five-year cumulative rate of 11.5% for B-rated debt might also be considered to be surprisingly high, but is it really? Consider that the average annual default rate calculated in the traditional way is 1.92% per year for the period 1978-1988. If we simply sum the one-year rates, the result is 9.60% for five years compared with our CMR of 11.5%. In addition, the traditional default rates are calculated

Table 3: Adjusted* mortality rates by original S&P bond rating; covering defaults and issues from 1971-1988.

		Years After Issuance									
Original Rating		1	2	3	4	5	6	7	8	9	10
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	0.00	0.00	0.00	0.00	0.00
	Cumulative (%)	1.97	3.81	8.01	23.05	24.64	24.64	24.64	24.64	24.64	24.64

Note:
* Adjusted for changes in population (cohort groups) due to defaults, calls and sinking fund redemption.

on the basis of the population on June 30 while our mortality rates use survival population data from the start of each year. Therefore, the "old" way probably understates default rates somewhat. 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 [5]. There are other biases, positive and negative in the calculation of traditional default rates and we will return to these points when we discuss several studies which which were published after our original working paper, which led to ALTMAN (1990).

Since we adjust the population for all redemptions as well as defaults, the mortality rates listed in Table 3 will be higher than if the population data was unadjusted. For example, the B-rated cumulative mortality rates, unadjusted for redemptions was 27.4% for 10 years. I believe that both the adjusted and unadjusted methods of calculating the results are meaningful. The mortality figures over time should adjust for changing population size while the unadjusted data could be helpful in examining the probability of default of a particular rating category from a given year's issuance. Strictly speaking, however, the unadjusted figures are not "rates". For a more in-depth discussion of this and a presentation of the entire unadjusted default amounts, see ALTMAN (1989 b).

5.2. Losses

As in the previous discussion on traditional measurements of default, the loss to investors from defaults is of paramount importance. In our ensuing analysis of net return spreads for each category of bond rating, we use the actual recovery amount that investors were able to sell the defaulting issue for and also assume that one coupon payment was lost. The average recovery rate was slightly below 40% of par.

We did look at the relation between individual bond ratings at issuance and the subsequent average price that could be realized upon default and found essentially that no relationship existed. Table 4 lists those results for 222 defaulting issues and shows that the average retention rate was actually 43.2% including Texaco and 38.8% without Texaco. Note that there is virtually no correlation for non-investment grade securities between initial bond rating and average price after default.

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 5). Therefore, while the marginal default rate is relatively low in the first three years after issuance (Table 3), the recovery rate is unaffected by the age of the issue.

Table 4: 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
All	43.18	222

Table 5: 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
All	43.76	219

5.3. Net Return Performance

An important dimension to our analysis is the ability to track 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 risk free U.S. Treasury securities. By factoring into the analysis actual losses from defaults and yield spreads over Treasuries, a more complete analysis results. We calculate actual return-spread performance, but the algorithm used is sufficiently robust to handle any set of assumptions on the variables analyzed.

Table 6 and Figure 1 present the return spread results across bond ratings over the sample period 1971-1988. The spreads, expressed in terms of basis points, compounded over a ten year investment horizon, are based on actual yield spreads for the nineteen year period. The average yield spreads were 0.47% (AAA), 0.81% (AA), 1.09% (A), 1.76% (BBB), 2.99% (BB), 4.08% (B), and 7.08% (CCC) [6].

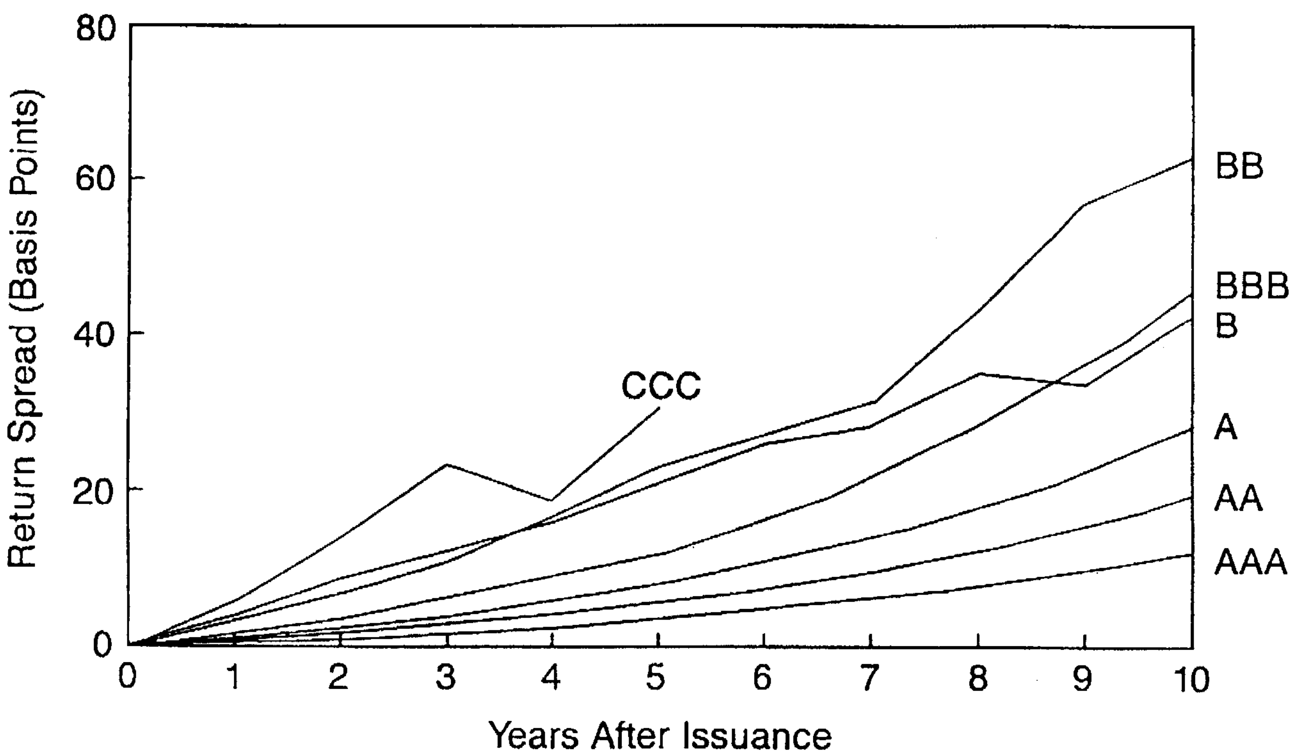
The body of Table 6 represents returns realized above what would have been earned on risk-free treasuries, measured in basis points. Table 6 uses actual long-term treasury coupon rates, yield spreads at birth for the different rating categories, the sale of defaulted debt, the loss of one coupon payment, and the reinvestment of cash flows at the then prevailing interest rates for that bond rating group. Cash flows are reinvested 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 show that AAA-rated bonds can be expected to earn 45 basis points (0.45%) more than Treasuries over one year (two semi-annual coupon payments) and 1201 bp. after 10 years. BB-rated bonds earn 313 bp. more than treasuries after one year and an impressive 6233 after 10 years. Another way to put this is an investment of $100 would

Table 6: Return spreads earned by corporate bonds over treasury bonds (measured in basis points compounded over time).

Years after issuance	AAA	AA	A	BBB	BB	B	CCC
1	45	76	105	171	313	370	572
2	100	169	222	367	666	849	1421
3	165	254	369	614	1097	1225	2312
4	246	373	558	901	1653	1583	1899
5	343	529	786	1229	2289	2077	3083
6	447	725	1051	1671	2714	2589	N/A
7	578	924	1370	2190	3164	2838	N/A
8	747	1215	1775	2856	4316	3515	N/A
9	954	1554	2259	3641	5639	3421	N/A
10	1201	1949	2853	4493	6233	4215	N/ A

Figure 1: Realized return spread on net investment in corporate bonds over risk-free governments.



return $62.33 more than treasuries over 10 years. Of interest is that for the first three years after issuance, the lower the bond rating the higher the net return spread, with triple CCC rated bonds doing best. In the fourth year, the CCC rated bonds do best but the B's drop off. After the fifth year, however, the BB-rated category begins to dominate while the B-rated bonds continue to lose ground. That relationship 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 4.08% yield spread for B-rated debt provides an ample cushion to compensate for losses, but the performance relative to the BB-rated category is inferior in the later years. This changes, however, if we adjust our initial yield spread assumptions to reflect different market conditions, assuming the same default experience. For example, in the period October 1987 to early 1988 and again in fall 1989, yield spreads on single-B rated bonds jumped to over 5.5%. 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 ten-year time frame.

6. Implications

The results indicate the expected adjusted mortality rates and losses, cumulated for a number of years after issuance, for all bond-rating categories. Despite some relatively high cumulative mortality rates over long holding periods, return spreads on all corporate bonds are positive, with impressive results for the high yield, low grade categories. If the analyst wishes to use higher (or lower) than historic mortality rates to reflect a number of macro- and micro-economic uncertainties, or different yield spread assumptions, that is certainly feasible.

Why do we observe such relatively consistent positive return spreads for all rating categories? The results show 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, our return spread results should be insignificantly different 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 debt issues and the discrepancy has persisted, perhaps because of the lack of appropriate information. That implies market inefficiency; if default losses are consistently lower than yield 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, however, for determining yield spreads on corporate bonds, then the market inefficiency conclusion is difficult to reach. For example, liquidity risk is often mentioned as important to price determination. If liquidity risk increases with lower bond ratings, then the excess returns noted earlier may in part be the returns necessary to bear this risk. Indeed, during the post-October 19, 1987 period, poor liquidity was cited as one cause of the precipitous drop in common-stock prices and the rise in yields of certain high yield debt issues.

The other risk element that is not isolated in our study is interest-rate or reinvestment risk. Actual returns on bonds are obviously affected by interest-rate changes. Our results include actual reinvestment rates over time and we have not factored in any capital gains or losses, assuming a buy and hold strategy for investors. BLUME and KEIM (1987) and ALTMAN and NAMMACHER (1985) have shown, however, that if anything lower grade bonds have lower volatility from interest rate changes than risk free, lower coupon treasuries.

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 recovery rate of an average 40% 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% average. In addition, the 40% 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 is perhaps necessary. On the other hand, if defaults are correlated with market returns, risks may not be as diversifiable as we assume to be the case for equities.

Investors might also be restricted in relation 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 can invest in such securities. That reduces demand and inflates yield and possibly return spreads.

Footnotes

[1] The default rate in 1989 was 4.035% with $8.1 billion of defaults.

[2] 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) did look at the loss on distressed exchange issues as well as losses from defaults and found that the overall average annual loss for the period 1978-1987 was 1.88%. Their base and reference population was only original issue high-yield debt.

[3] Non-rated debt is not included in our formal analysis because the risk nature 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.

[4] In addition, the later year results could be biased since a portion of the original population of bonds will be redeemed by then. If more credit worthy firms tend to be called earlier than more risky ones, then the later year mortality rates would be biased upward. In addition, we did not include in our return calculation any call premiums or warrant value which might have been attached to the bond issue. Our results, however did not show a great deal of difference when we did not exclude redemptions (results without redemptions are available from the author).

[5] If we begin our analysis in 1976, rather than in 1971, the five-year B-rated cumulative rate is slightly higher at 11.7%; the eight-year rate is 23.7%; and the 10-year rate is 36.4%. The latter is due to the relatively high nine and ten-year defaults of 1977 new issues ($85.5 million and $26.7 million respectively from the $526 million issued).

[6] In an earlier version of this paper, ALTMAN (1989 a), we assumed yield spreads of 0.50, 1.0, 1.5, 2.0, 3.0, 4.0, and 5.0 percent for AAA, AA, A, etc., respectively. Except for the CCC rate, the actual average yield spreads are quite similar to these assumptions.

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