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Source: *The Journal of Finance*, Vol. 42, No. 1 (Mar., 1987), pp. 81-97
Published by: Blackwell Publishing for the American Finance Association
Stable URL: http://www.jstor.org/stable/2328420
Accessed: 26/11/2009 08:06

THE JOURNAL OF FINANCE • VOL. XLII, NO. 1 • MARCH 1987

The Default Premium and Corporate Bond Experience

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ABSTRACT

The development of organized markets for speculative-grade corporate debt has provided financial researchers with an opportunity to examine the pricing of default risk. By incorporating previous work on the default experience of low-rated corporate debt, this paper presents an introduction to risk-neutral models of risky-bond pricing and uses these to examine the relationship between the default premium embodied in bond yields and actual default rates. The contribution of macroeconomic information to the default premium is also examined. The author finds that holders of low-grade bonds have, on average, been compensated for losses due to default.

THE EMERGENCE OF ORGANIZED markets for low-rated corporate (or junk) bonds has provided financial researchers with an opportunity to address a fundamental question: Are holders of default-prone debt compensated (actuarially) for the risk of default? Past research on this market has focused on the default experience of corporate debt. A quite different area of research involves modeling the spreads between the returns of bonds of different credit quality. Few (if any) research efforts have combined these approaches by using actual default experience to explain differential rates of return on low-rated bonds.

In this study, a risk-neutral model of the expected probability of default for low-grade bonds is developed as a function of the additional required rate of return on these instruments over default-free bonds. A pricing relationship is derived for the yields to maturity of risky bonds as well as their holding period returns. The default rates implied on corporate bond yields are then compared with a series based on recent corporate bond default experience. Measured holding-period returns, however, are shown to be poor indicators of expected default rates. Next, a "naive" model of expected default rates is suggested as an alternative to the risk-neutral model and subjected to similar tests. Finally, the response of the default premium to changes in the economy is examined. Deviations from expected values of a group of macroeconomic measures will proxy for these changes.

In an early paper on the subject of default-risk premia, Fisher [7] suggested that the risk premium required on a corporate bond (holding maturity constant) depends on the likelihood that the issuing firm will default (defined here as a

* Federal Reserve Bank of Cleveland. The paper is based on part of the author's Ph.D. thesis completed at the University of California, San Diego. The author would like to thank his advisor, Ross Starr, and Bill Gavin for helpful comments and Jim Balazsy for capable research assistance. The views stated herein are the author's and not necessarily those of the Federal Reserve Bank of Cleveland or of the Board of Governors of the Federal Reserve System.

failure to pay any coupon or principal payments when due) and on the "marketability" of the bond. In addition, modern approaches acknowledge the influences on required returns that result from call provisions, the tax effect for deep discount bonds (due to the different tax treatment of ordinary income vs. capital gains), and sinking fund payments (which reduce the average maturity of a firm's debt). Isolating the influence of default likelihood on interest rate differentials involves controlling for these other effects.

In order to test hypotheses concerning the models derived in this paper, we assume that bond market participants are in complete agreement as to the probability of default for a particular issue. We further assume that all bonds are perceived, and therefore priced, as having the same likelihood of default as others in the same rating category. Ideally, the same assigned rating gives, in a single measure, the rating agency's estimate of the issue's probability of default.

Past research on the importance of rating changes on bond price movements offers somewhat mixed results. Hettenhouse and Satoris [8], as well as Weinstein [12], conclude that market participants incorporate new information before a rerating. On the other hand, Ederington, Yawitz, and Roberts [5] find that the market responds to rating changes in addition to publicly available information. They also conclude that ratings by Moody's and Standard & Poor's are equally reliable indicators of an issue's creditworthiness.

In order to isolate expected default probabilities, we will restrict our attention to two broad classes of ratings: investment grade and speculative grade. Investment-grade corporate bonds carry a rating of Baa3 or higher (from Moody's), BBB− or higher (from Standard & Poor's), or both, while speculative-grade bonds consist of issues with ratings below these, as well as corporate bonds that are nonrated.

Section I contains a discussion of the construction of the default rate series used in this paper. In Section II, we present a model of the pricing of default-prone bonds in terms of their required yields to maturity and compare derived implied default rates with actual default experience. Section III repeats this exercise for holding-period returns and discusses the complications inherent in this measure. Section IV is devoted to the comparison of the performance of the model derived in Section II with an alternative model of expected default rates. An examination of the influence of macroeconomic surprises on the default premium is presented in Section V. In Section VI, we present a summary of the paper and some closing remarks.

I. Measuring Corporate Defaults

Economists have tracked the performance of corporate debt beginning with a study by Hickman [9]. His and almost every subsequent study define the rate of default as the value of issues defaulting during a specified period divided by the value of bonds outstanding over some part of the period (usually the beginning). Altman and Nammacher [1] (A&N hereafter) argue that, since almost all corporate defaults over the last few years have occurred in the low-rated sector, the appropriate measure of the corporate default rate includes only the value of low-rated bonds in the denominator.

Since bond ratings are not permanent designations, the default rate for bonds of a particular rating cannot be meaningfully addressed. Before the typical issue defaults, it has been gradually downgraded until it reaches the rating D (for Default). In A&N and in this study, only publicly held, straight (nonconvertible) corporate debt with a speculative (or no) rating is included in the denominator. Convertible-bond defaults were included in the numerator for our measurements, however, because of the likelihood that market participants do not differentiate between losses in this sector and the straight-bond sector. In the six-year period from the beginning of 1980 through 1985, a total of \$3.586 billion of corporate debt defaulted, roughly \$1.021 billion of which consisted of convertible issues. Eliminating these defaults would substantially reduce our measured default rates. The actual default rate series presented below is therefore biased upwards.

Figure 1 presents a monthly time-series plot of annualized default rates for January 1980 through December 1985. This was constructed by dividing the par value of bonds defaulting at each month by the par value of outstanding low-rated bonds at each date. The par value of defaulting issues was obtained from A&N (up to December 1984) and Standard & Poor's Bond Guide (through December 1985). Observations on the par value of speculative-grade bonds outstanding were taken at the end of each year from Standard & Poor's Bond Guide. Estimates of outstanding bonds, by month, were obtained by interpolating annual measures. The mean of this default series is 1.883 percent, with a standard deviation of 3.297 percent. The series reaches a minimum of zero at several points, including part of 1981, and attains a maximum of 19.504 percent in April 1982.

For some of the analysis, a smoothed default rate series is employed, partly because of the volatile nature of actual default rates. A smoothed version was constructed by summing at each date defaults occurring over the past twelve months and dividing by outstanding low-rated bonds six months earlier. This is essentially a twelve-month moving average of the monthly default rate series. From January 1980 through December 1985, the average value of our smoothed default rate series is 1.796 percent, roughly corresponding to A&N's estimate of

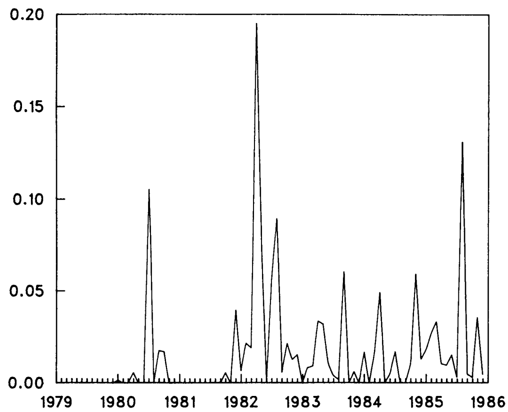

Figure 1. Actual Monthly Default Rate Series (in Annual Rates); Source: Altman and Nammacher [1] and Standard & Poor's Bond Guide.

1.507 percent (obtained from year-end observations for January 1978 through December 1984). Our smoothed default rate series has a standard deviation of 1.273 percent. The maximum value of 4.756 percent occurs in November 1982, while the minimum of 0.045 percent occurs in October 1981. A summary of these series and all subsequent data series can be found in Table I.

We note that the constructed series represent defaults rather than losses to bondholders. In fact, A&N find that defaulting bonds continue to trade at forty-one percent of par within one month following the default. Given that the bondholder can usually sell the defaulting security, recovering a portion of his or her original investment, the actual investor "loss rate" is somewhat lower than our default rate estimates.

II. Default Rates and Yields to Maturity

The theoretical model derived herein is based on the pioneering work of Bierman and Hass [2], with subsequent extensions by Yawitz [13]. This model is in the same spirit as that used by Yawitz, Maloney, and Ederington [14] to model yield spreads in the municipal bond market on the basis of differing default probabilities and tax effects.[1]

Modern asset-pricing models are usually developed using the first and second moments of the return distribution. With risk-neutral preferences, however, agents consider only the first moments of the distributions of return; the security's expected return completely determines its market price. The certainty-equivalence framework is especially useful because it greatly simplifies the construction of a testable pricing relationship.

Assume that a promised coupon (or principal) payment will be rendered at the end of a given period with a perceived probability P. A payment promised t periods from now is expected to be received with probability P^t. A default occurs (and applies only to payment streams for which there have been no previous defaults) with probability $(1 - P)$, implying that the probability mass applied to the defaulting payment stream t periods from now is $P^{t-1}(1 - P)$. In the event of a default, a fraction of the promised coupon and principal payments is received, denoted here by μ.

If capital markets are frictionless and information is costless, arbitrage will force the market price of a certainty-equivalent (default-risk-adjusted) payment stream, discounted at the riskless rate of interest, to be equal to a risky stream discounted at the appropriate risky rate of interest. Dividing all promised payments by the face value of the risky bond, the following relationship must hold:

$$\sum_{t=1}^{N-1} \frac{P^t C + P^{t-1}(1 - P)\mu(C + 1)}{(1 + i)^t} + \frac{P^N(C + 1) + P^{N-1}(1 - P)\mu(C + 1)}{(1 + i)^N} = \sum_{t=1}^{N} \frac{C}{(1 + r)^t} + \frac{1}{(1 + r)^N}, \quad (1)$$

where i is the riskless rate of interest, r is the risky rate of interest, C is the promised risky coupon rate, and N is the number of years to maturity.

[1] Yawitz, Maloney, and Ederington [14] do not compare their estimates of default rates in the municipal market with actual rates.

Table I

Summary of Measured and Constructed Series

	Mean	Standard Deviation	Minimum (Date)	Maximum (Date)
12/79–12/85				
i	0.12434	0.01543	0.0988 (11/85)	0.1625 (9/81)
r	0.15836	0.01472	0.1342 (4/83)	0.1950 (9/81)
C	0.12376	0.00687	0.1103 (12/79)	0.1353 (12/85)
N	17.3623	1.1710	15.000 (12/85)	19.333 (9/81)
$(1 - P)$	0.04937	0.01075	0.0320 (2/80)	0.0727 (12/85)
ADR† (1-month)	0.01857	0.03281	0.00000 (23 points)	0.19504 (4/82)
ADR (12-month)	0.01776	0.01276	0.00045 (10/81)	0.04756 (11/82)
1/80–6/84				
h^* (1-month)	0.01418	0.03538	−0.0467 (5/84)	0.1409 (11/81)
H (1-month)	0.00901	0.04305	−0.0799 (4/81)	0.1315 (11/81)
$(1 - m)$† (from 1-month HPY)	0.00732	0.43032	−1.3765 (3/80)	0.7787 (12/81)
12/80–6/84				
h^* (12-month)	0.19921	0.18482	−0.0742 (9/81)	0.5403 (4/83)
H (12-month)	0.13404	0.19827	−0.1296 (6/81)	0.4999 (10/82)
$(1 - m)$ (from 12-month HPY)	0.08858	0.06637	−0.1009 (12/82)	0.2164 (10/83)

† Expressed as an annual rate.

Using a geometric sum formula to express (1) without summations, we have

$$\frac{[PC + (1 - P)\mu(C + 1)][P^{N-1} - (1 + i)^{N-1}]}{[P - 1 - i](1 + i)^{N-1}} + \frac{P^{N-1}[P(C + 1) + (1 - P)\mu(C + 1)]}{(1 + i)^N} = \frac{1}{(1 + r)^N} - \frac{C[1 - (1 + r)^N]}{r(1 + r)^N}. \quad (2)$$

The yields to maturity, i and r, are for bonds that are identical in all respects except for the likelihood of default. Further simplifications of the above expression are possible if one approximates the finite-maturity coupon bond with a perpetuity and if one assumes that default results in a total loss to debt holders.[2]

A more general specification of equation (1) would incorporate time subscripts

[2] If one approximates the finite-maturity coupon bond with a perpetuity—multiplying the left-hand side of (2) by $(1 + i)^{-N}/(1 + i)^{-N}$ and the right-hand side by $(1 + r)^{-N}/(1 + r)^{-N}$ and letting N approach infinity—then (2) becomes

$$\frac{PC + (1 - P)\mu(C + 1)}{(1 + i) - P} = \frac{C}{r}.$$

for the variable P, so that expected payment rates would be allowed to vary over calendar time (hence the term structure). The product of the P's from the initial date to the relevant payment dates would replace P^t in the first term of the numerators of the left-hand side of (1). The product of the P's from the initial date to the date preceding the payment date would be multiplied by 1 minus the expected payment rate in the relevant period for the second term. The difficulty of using this version of the model is that there is no way to identify the values of the separate expected probabilities of payments. In addition, a closed-form solution like that of equation (2) could not be found. The single stationary measure of P can be interpreted as a weighted-average likelihood of payment, summarizing expectations of future payment rates.

A. *Yield-to-Maturity Data*

An index of yields to maturity for low-rated bonds was obtained from Salomon Brothers' Corporate Bond Research department. The index used begins at the end of 1979 and is constructed from a sample of 176 bonds (as of September 1985), weighted by the outstanding principal amount of each issue (to control for each issue's relative influence on market rates), that meet the following criteria: (a) more than $25 million in principal outstanding (assuring adequate marketability), (b) ratings below Baa3 or BBB−, or not rated but of lower quality than Baa3 or BBB−, (c) a coupon of ten percent or more, and (d) longer than ten years in maturity.[3] In addition, we were able to obtain the weighted coupon rates and weighted maturity date for the sample at each point in time. Defaulting bonds are removed from the sample, as are issues that are upgraded to investment-grade status.

Difficulties arise in the analysis because of several uncontrolled factors. In addition to the relative thinness of markets for low-grade corporate debt, nearly all corporate bonds contain call provisions. In a sample of 702 currently outstanding, publicly held, low-rated (or nonrated) issues, all but 32 had call provisions, and 97 were being called as of January 1986. In practice, many (high-coupon) low-rated bonds trade on a yield-to-call basis. Of course, high-grade corporate bonds also carry call provisions. The extent of the risk to a bond holder of an early call depends upon whether or not the security trades significantly above par. The fact that most of the low-rated bonds in our sample have high coupons (to the point that they might trade above par if overall rates fall) reduces the likelihood that there is a comparable high-grade index that exactly matches each of the characteristics (apart from default risk) of the low-rated sample.

Given these concerns, the yields to maturity for high-grade corporate bonds were taken from Salomon Brothers' New Medium Term Industrials index for

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If we assume that default results in a total loss to holders ($\mu = 0$), then this becomes

$$1 + r = (1 + i)/P.$$

[3] For the 176 issues in Salomon Brothers' Low-Rated Index, as of September 1985, 23 were rated BB (by Standard & Poor's), 26 were rated B+, 34 were rated B, 45 were rated B−, and 48 were rated CCC. A&N find that the highest default-risk group (in terms of rating at issuance) was bonds rated single B. This index, therefore, represents the average returns of the riskiest corporate bonds.

Aaa-rated bonds, found in their Analytical Record of Yields and Yield Spreads. This series is based on estimates (by Salomon's Syndicate Department) of the required yields on issues coming to the market that are rated Aaa and that will mature in ten years. These estimates were made at the beginning of month $t + 1$ and were aligned with the low-rated index observations that were taken on the last day of month t.

It has been observed that new corporate issues are priced at yields slightly higher than seasoned issues, due to their relative lack of liquidity. The Aaa/AAA-rated yields were chosen to represent the default-risk-free rates largely because of the lack of defaults by bonds originally issued with this rating in the past fifteen years. Using the yields on long-term U.S. Treasury issues as the default-free yield would complicate the analysis because these securities lack call provisions and because their returns are subject to a different tax treatment. In addition, the shear volume of transactions involving Treasury bonds introduces the possibility that yield differentials reflect a marketability factor.[4]

Finally, cross-sectional variations in the measured returns of a sample of representative bonds can be attributed to firm-specific idiosyncrasies. It is assumed that the average measured returns will vary systematically as the result of the default experience of corporate bonds. The use of a weighted average of bond returns causes the influences of the idiosyncratic variations to cancel one another. Hickman [9, p. 66] discusses the difficulties of using (weighted-) average returns as measures of the return on a pooled investment portfolio. He concludes that, under most conditions, the error will be negligible.

B. Comparison of Actual and Implied Default Rates

A numerical solution program was employed to solve (2) for the expected "payment rate," P, given the values of the indexes r, i, μ, C, and N, at the end of each month t. This estimate of the cross-sectional average of implied expected payment rates is based on the characteristics of a cross-section of low-rated bonds. A complication arises, however, because of the aggregation procedures used.

Let us assume that P is an implicit function of r (with i, μ, and N held fixed). Since (2) cannot be solved specifically for P, a computer simulation was employed to graph the implicit function with restrictions on the values of the other variables and a restriction on the relationship between C and r (to partially adjust for the influence of par-valued new issues on the average coupon rate as yields change). Figure 2 is a graph of this relationship. Note that, when payment rate P is equal to 1, the risky rate takes on the supplied value of the riskless rate (ten percent here). Since the relationship between P and r is convex over plausible values of r, Jensen's inequality suggests that the cross-sectional average of P will be greater than or equal to the measured payment rate. This implies that our estimate of $(1 - P)$, the implied expected default rate, is biased downwards. The extent of

[4] Coupon payments received from Treasury securities are currently exempt from state and local income taxes. Ibbotson and Sinquefield's [10] measured default premium, constructed by subtracting the holding returns of Treasury bonds from those of AAA/Aaa-rated corporates, may reflect this tax differential as well as a liquidity premium.

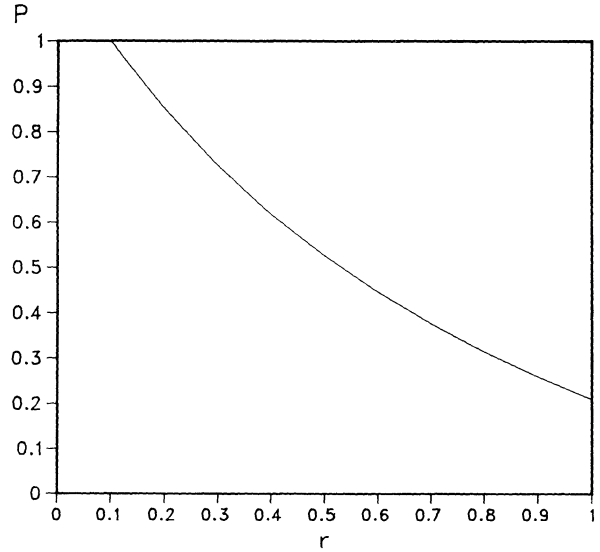

Figure 2. Plot of r against P (computed with $\mu = .41$, $i = .1$, $N = 14$, and $C = .913\ r$). The last restriction is an adjustment for the influence of yield changes on average coupon rates due to new issues, incorporating the average price of corporate debt as of 12/85; Source: See Text.

the bias, however, depends upon the cross-sectional variance of the rates used to calculate r. Lacking such information, we note that the curvature of the implicit function in the relevant neighborhood is quite small, so that this bias should be negligible.

A time-series plot of $(1 - P)$, the expected default rate implied by our model of yield differentials, is presented in Figure 3 along with a plot of the moving-average default series. The fact that the implied expected default rate series appears to track, and even lead, smooth actual default rates so well is surprising, given that the implied rate represents an average of expected future default rates. The spread between implied and actual (smoothed) default rates is also surprisingly large and persistent over this period.

Acknowledging the statistical complications introduced by the construction of these variables, additional insight may be gained by using regression techniques. Cochrane-Orcutt-adjusted regressions of $(1 - P)$ on constants and the "raw" default rate series, ADR, as well as the smoothed default rate series, SADR, are presented below in Table II. These regressions indicate that there is some connection between the measured implied default rates and the two actual default rate series. The adjusted R-squares of 10.2 and 11.1 percent, respectively, indicate the percentage variation in the implied default rate series that is "explained" by the two measures of actual default rates.

Figure 3 suggests that a stronger overall relationship exists between implied and smoothed actual default rates than these results indicate. Consequently, a smoothed implied default rate series was constructed by forming an equal-weight moving average of $(1 - P)$ extending five months back from each date (for an average of six months). The results from regressing this series on a constant and the smoothed actual default rate series are also given in Table II. The adjusted

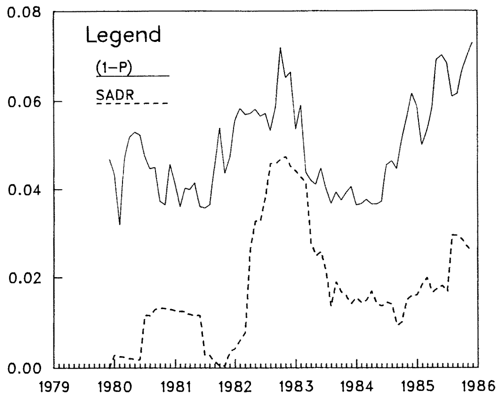

Figure 3. Time Series of (1 − *P*) and Smoothed Actual Default Rates; Source: See Text.

Table II

Implied Default and Performance Rates on Actual and Smoothed Default Rates

Dependent Variable	Constant	ADR	SADR	$\bar{R}^2$	DW
12/79–12/85					
$(1-P)$	0.0504	−0.0058		0.102	1.90
	(17.82)	(−0.35)			
$(1-P)$	0.0479		0.1413	0.111	1.89
	(12.43)		(1.00)		
$(r-\mathrm{i})$	0.0307		0.2029	0.152	1.87
	(12.20)		(2.14)		
5/80–12/85					
$(1-P)$*	0.0472		0.1691	0.313	1.52
	(26.39)		(3.99)		
$(r-i)$*	0.0319		0.1290	0.251	1.60
	(29.18)		(4.26)		
1/80–6/84					
$(1-m)$ (from 1-month HPY)	0.0108	−0.2606		−0.019	1.99
	(0.18)	(−0.15)			
12/80–6/84					
$(1-m)$ (from 12-month HPY)	0.0926	−0.2586		0.013	2.08
	(3.93)	(−1.34)			
$(1-m)$ (from 12-month HPY)	0.1320		−2.207	0.084	2.01
	(5.51)		(−2.35)		

Note: regressions were run using the Cochrane-Orcutt procedure for first-order serial correlation except those marked with *, corresponding to smoothed series, which were corrected for first- and second-order serial correlation. The reported Durbin-Watson statistics are less powerful when the serial adjustment technique is used. *t*-Statistics are reported in parentheses.

R-square rises to 31.3 percent when using this smoothed series, further substantiating the underlying relationship.

The large *t*-statistics for the constant terms in all three regressions cause us to reject the null hypothesis that the market's estimate of default corresponds to actual default rate experience. In fact, evidence suggests that market yields imply default rates that exceed actual default rates by roughly five percentage points. The difference between implied and actual default rates was regressed on a constant and tested for a structural break at the peak of smoothed actual default rates (November 1982). The results indicate that, at the five percent level, no such break occurred.

III. Default Experience, Holding-Period Yields, and Ex Post Performance

In this section, we apply the default-risk-neutral framework to the pricing of risky debt in terms of the expected holding-period yields on default-prone and default-free bonds. A bond's holding-period return embodies changes in the market price as well as coupon earnings (prorated for the holding period). Define B_t to be the default-free bond's market price at the end of period t, and C_t to be the promised coupon payment earned in period t. Now let the holding-period return for a default-risk-free bond be defined by H_t, such that

$$H_t = \frac{B_t - B_{t-1} + C_t}{B_{t-1}}. \tag{3}$$

The corresponding gross return to the holder of a default-prone bond with price B_t^* and coupon C_t^* in period t is represented by

$$h_t^* = \frac{B_t^* - B_{t-1}^* + C_t^*}{B_{t-1}^*}. \tag{4}$$

Note that H_t and h_t^* are period-specific returns, in turn, convertible to annual yields.

Now let m_t be the perceived probability that an issuer will not default over period t, conditional upon a default not having previously occurred. If the period under consideration is a single month, then $(m_t)^{12}$ is the expected probability that the firm will not default within a year.

Let us further assume that, in the event of a default, the holder of the risky bond will receive with certainty a fraction μ of the beginning period price B_{t-1}^*. The investor's expected (net-of-default) return on the risky bond, $E(h_t^*)$, is therefore given by:

$$E(h_t^*) = \frac{m_t(B_t^* + C_t^*) - B_{t-1}^* + (1 - m_t)\mu B_{t-1}^*}{B_{t-1}^*}. \tag{5}$$

For the certain nondefault case (in which m_t equals 1), $E(h_t^*)$ will equal h_t^*. In the case of certain default, $E(h_t^*)$ will equal $(\mu - 1)$, resulting in a loss to the bondholder. In the absence of market imperfections, equilibrium in the risk-neutral setting requires that the expected net-of-default returns on the default-prone and the default-free bonds will be equal. Setting the right-hand side of (5) equal to H_t and using equation (4), we have

$$H_t = m_t(h_t^* + 1) - 1 + (1 - m_t)\mu. \tag{6}$$

Subtracting both sides of (6) from h_t^* and rearranging gives

$$\frac{h_t^* - H_t}{h_t^* + (1 - \mu)} = (1 - m_t), \tag{7}$$

where $(1 - m_t)$ is the period-specific default rate embodied in the expected holding-period yields of the default-prone and default-free securities, given an assumed recovery rate, μ.[5] Note that (7) represents a risk-neutral, ex ante relationship between expected holding-period returns and expected default rates.

A bond's realized holding period return, however, is an ex post measure of performance. Conversely, measured yields to maturity are based on expected performance and embody ex ante expected default rates. Actual bond holding-period returns may deviate from expected returns, limiting our ability to measure implied default rates from the difference between holding-period yields of risky and risk-free bonds.

Consider a short-run increase in the expectation of corporate defaults. Ceteris paribus, this would have the effect of reducing the prices of outstanding low-rated bonds, thereby reducing the measured holding-period return h_t^*. Under most conditions, this would lower the "implied" default rate $(1 - m_t)$.[6] Indeed, below we show that relatively short-run price movements (resulting from new default information) can cause the right-hand side of (7) to take on negative values, thereby violating the definition of a probability. Therefore, (7) cannot be used to obtain implied default rates. What one obtains from applying this formula to ex post returns is a differential "performance rate" for low-rated bonds.

A. Holding-Period Data

A proxy for h_t^* was constructed monthly by Blume and Keim [3], based on the price movements and coupon payments of the bonds used in Salomon Brothers' Low-Rated (or High-Yield) Bond Index (discussed above) and the Drexel Burnham Lambert 100 Index. The series starts at the end of January 1980 and covers through June 1984. It has a mean of 1.14 percent (for an equivalent annual average return of 14.57 percent) and a standard deviation of 4.09 percent.[7]

As a measure of the holding-period returns on default-free bonds, H_t, we used Salomon Brothers' High-Grade Index for total rate of return found in their Analytical Record of Yields and Yield Spreads. (This data series was discontinued after December 1985.) The index was formed by calculating the total returns of roughly 900 issues with weights based on issue size. The weights are revised monthly, and bond issues are included and deleted as ratings are updated. The average weighted maturity of the issues at the end of 1985 was 22.1 years. This series is also used as a benchmark return by Blume and Keim [3].

[5] As in footnote 2, the assumption that default results in a total loss to bondholders (i.e., $\mu = 0$) gives

$$1 + h_t^* = (1 + H_t)/m_t.$$

[6] The partial derivative of $(1 - m_t)$ with respect to h_t^* is

$$[H_t + (1 - \mu)]/[h_t^* + (1 - \mu)]^2$$

and will be positive when $H_t > (\mu - 1)$. The smallest value reached by the one-month holding-period return on the high-grade series from January 1980 through June 1984 is −0.0799. The 12-month holding period minimum for this rate is −0.1296. Based on A&N's estimates, $(\mu - 1)$ equals −0.59, implying that this condition will be met under most circumstances.

[7] See Blume and Keim [3] for a description of this series.

B. Comparison of Actual and Implied Default Rates

In order to minimize extraneous influences on holding-period yields, a holding period of one year was selected, in addition to the one-month holding period. The Blume-Keim series was converted to an annual return series by accumulating monthly returns over the past year at each month. This gives, at each date, the holding-period return of bond holders who sold a security purchased one year earlier (and collected coupon payments for the period). Measured in this fashion, (7) implies that annual performance rates are estimated.

In Figure 4, we present a plot of the performance rate implied by equation (7), obtained from annual holding-period measures, along with the actual moving-average default rate, $SADR_t$. Confirming our intuition, negative performance rates exist when actual default experience is highest. The performance rate, $(1 - m_t)$, reaches a minimum value of -0.1009 in November 1982, the month following the maximum value reached by the smoothed actual default rate series. It is clear that periods corresponding to negative performance rates are those in which one-year holders of low-rated bonds realized significant losses. In general, the performance rate series descends as actual default rates rise, and vice versa.

In Table II, we present the regressions of the measured performance rates (expressed in annual terms and based on one- and twelve-month holding-period yields) on the raw and smoothed actual default rate series. The low R-squares indicate that relatively little of the variation in performance rates is explained by actual default rates. The negative coefficients on actual default rates and the significant t-statistic on the smoothed default rate series provide further evidence for the negative correlation between actual default rates and the performance of low-rated bonds. The significant (and positive) t-statistics on the constant terms of the regressions, using a performance rate series formed from twelve-month holding-period yields, indicate that, on average, holders of low-rated bonds realized holding-period gains relative to their high-grade counterparts over our sample period.

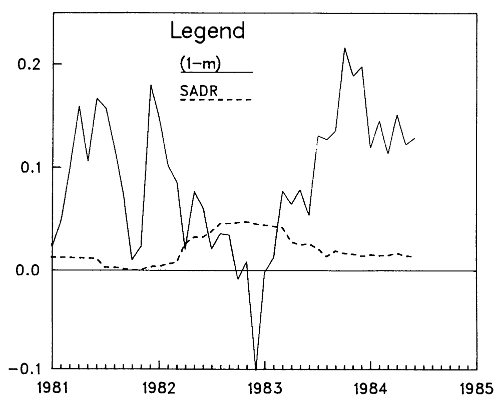

Figure 4. Time-Series Plot of $(1 - m)$ and Smoothed Actual Default Rates; Source: See Text.

IV. An Alternative Pricing Model and Corporate Bond Experience

The discrepancy between the rates of default implied by the risk-neutral model developed in Section II and actual (smoothed) default rates suggests two possible conclusions. The first is that somehow the market for low-rated debt is inefficient in that arbitrage opportunities exist. An alternative conclusion is that the risk-neutral model used here (and elsewhere) is deficient. The existence of a different specification that conforms more closely to actual default rate experience would tend to bolster support for the latter view.

A simple model that could conceivably be used by participants in the market for low-rated corporate debt is the following: if actual (expected) default rates are X percent, then the required yield to maturity on low-rated debt should exceed that on comparable-maturity high-grade debt by X percent. Given its simplicity, we shall refer to this as the rule-of-thumb model of expected default rates. According to this model, the difference in the values of the indexes for the yields to maturity of low- and high-grade corporate bonds is a direct measure of expected default rates on low-rated debt.

We formed the difference in the indexes of the yields to maturity on low- and high-grade debt $(r - i)$ and regressed this difference on a constant and smoothed actual default rates, SADR, over the period covering January 1980 through December 1985. The results, given in Table II, indicate that this series does indeed have a higher correlation with smoothed actual default rates than does $(1 - P)$. This is evidenced by the higher adjusted R-square for the regression and the t-statistic for SADR. The smaller intercept value also implies that this indicator of expected defaults is, on average, closer to actual default rates than the risk-neutral measure found from equation (2).

A six-month moving average of $(r - i)$ was formed and regressed on a constant and smoothed actual default rates, with the results also appearing in Table II. The adjusted R-square for this regression is lower than that for the smoothed $(1 - P)$ regression reported above, although the t-statistics for both the intercept and SADR are still slightly higher. We cannot conclude that the rule-of-thumb model significantly outperforms the risk-neutral model as a predictor of actual default rates. Indeed, from the construction of equation (2), one would expect these two measures to be highly correlated. A regression of $(r - i)$ on a constant and $(1 - P)$ has an adjusted R-square of 73.96 percent with a coefficient and t-statistic of 0.5765 and 14.24, respectively, for $(1 - P)$. The corresponding values for the intercept term are 0.0053 and 2.61. A higher R-square would no doubt result if coupon and maturity measures were constant over the sample period.

The apparent success of the rule-of-thumb model may be the result of convention. If participants in the market for low-rated debt use this rule in determining required rates of return, then one would expect to find a high correlation between expected default rates using this measure and actual default rates. If such a bias does indeed exist, then the incremental performance of the rule-of-thumb model (without smoothing) tells us little about the deficiency of the risk-neutral model of Section II. It is interesting to note, however, that the highly significant intercept term in the regressions of $(r - i)$ (raw and smoothed) on SADR and a constant substantiates the presence of a reward for bearing default risk, albeit a smaller one than that implied by the risk-neutral model.

V. Default Expectations and Macroeconomic Measures

In this section, an attempt is made to allow for the influence of other macroeconomic variables, in addition to actual corporate default rates, on implied default and performance rates. Past studies of differential quality spreads have used an assortment of macroeconomic indicators. Jaffee [11] examines factors that influence the risk spread of corporate yields in a cyclical fashion. He finds that the most significant variable in explaining the risk spread is a measure constructed by Fair [6] based on data collected by the University of Michigan Survey Research Center, which acts as a proxy for consumer sentiment. This factor was also employed by Cook and Hendershott [4], in addition to others, to explain the spread between high-grade corporate and Treasury securities. Rather than take this approach, implied default and performance rates are tested for correlation with new default information and surprises in macroeconomic measures.

It is well known that, in periods of (unanticipated) rising prices, firms with fixed nominal financial obligations tend to benefit. Conversely, (unanticipated) reductions in prices may cause hardship to some firms. Since expected inflation will already be incorporated into the contracts, it is the unanticipated part of inflation that should have the most effect on the probability of default. Therefore, a natural macroeconomic proxy is the deviation of the percentage change in the consumer price level from expectations. Other indicators of macroeconomic activity that may be correlated with default expectations are the Board of Governors of the Federal Reserve System's industrial production index and the Labor Department's unemployment rate estimate.

Two characteristics of our sample period tend to limit the effectiveness of this exercise, however. The first is the relatively short sample period available for study. The size of the market for low-rated bonds approached significance only toward the end of the 1970's. The identification of long-run relationships is thus seriously hampered. Second, the sample period of this study is one in which the overall inflation rate was, on average, falling, concluding a long period of accelerating inflation. The effect of this regime switch on the reported results is indeterminate, introducing the possibility that the behavior of market participants over a longer period may well differ from that exhibited recently.

In order to test for a relationship between unanticipated inflation rates and our estimates of implied default and performance rates, we constructed an unanticipated inflation series by subtracting one-month-ahead forecasts of the percentage change in the CPI (obtained from Money Market Services) from actual monthly percentage changes. Similar series were constructed for measures of the unemployment rate and the percentage change in industrial production (a monthly proxy for GNP). One would expect that, if agents incorporate new information concerning the economy into their expectations of default rates, these proxies will be related to changes in expected default rates.

For various sample periods, we regressed the first differences of implied default

Table III

Implied Default and Performance Rates on Actual Default Rates and Macroeconomic Surprises

Dependent Variable	Constant	ADR	Inflation	Industrial Production	Unemployment	$\bar{R}^2$	DW
(Dependent Variable First Differenced)							
2/80–12/85							
$(1 - P)$	−0.0001	−0.0156	−0.0015	0.0006	−0.0009	−.036	2.13
	(−0.05)	(−0.70)	(−0.64)	(0.63)	(−0.23)		
2/80–6/84							
$(1 - m)$†	0.0499	1.0762	0.1095	0.0171	0.0977	−.060	2.27
	(0.29)	(0.49)	(0.54)	(0.26)	(0.26)		
(Dependent Variable and ADR First Differenced)							
2/80–12/85							
$(1 - P)$	−0.0006	−0.0087	−0.0019	0.0005	−0.0009	−.039	2.13
	(−0.43)	(−0.56)	(−0.86)	(0.53)	(−0.26)		
2/80–6/84							
$(1 - m)$†	0.0948	0.4416	0.1466	0.0252	0.1235	−.065	2.28
	(0.67)	(0.22)	(0.79)	(0.40)	(0.34)		

Note: t-statistics are reported in parentheses.

† Run using the Cochrane-Orcutt procedure for first-order serial correlation.

rates, $(1 - P)$, obtained as in Section II, on a constant, actual default rates (in levels as well as first differences), unanticipated inflation, unanticipated industrial production, and unanticipated unemployment. The macroeconomic surprises were lagged one month, as the timing of the actual series normally lags the reported period by a few weeks. The results, found in Table III, indicate that, of the three macroeconomic indicators, surprises in reported measures of industrial production have the highest correlation with implied expected default rates although the level of actual default rates contributes slightly more. When the first differences of actual default rates are used, the surprise in inflation appears to have the highest (negative) correlation with expected default rates. Note, however, that no variable enters significantly in either regression at the 95% confidence level. The low adjusted R-squares also lead us to conclude that current macroeconomic surprises are poor indicators of expected default rates.

The same regressions, adjusted for serial correlation of the error terms, were run using the implied performance rate (based on one-month holding-period yields converted to annual rates) in place of expected default rates. Also found in Table III, these results suggest that, although insignificant at the 95% confidence level, surprises in inflation are most closely related (positively) to performance rates. We conclude that, of the macroeconomic indicators, deviations from expected inflation rates contribute the most (in addition to new default information) to changes in expected default rates.

VI. Summary and Conclusions

This paper represents the first effort to establish a relationship between the risk premium required by holders of low-rated corporate bonds and the actual default experience of these issues. A model of low-rated bond pricing, developed in a risk-neutral setting, is used to estimate expected default rates on these issues. This series is then compared with the actual default experience of low-rated debt. We find that the default rates implied in corporate bond returns exceed those experienced in recent years. As a result, holders of well-diversified portfolios of low-rated corporate bonds appear to be rewarded for bearing default risk. We also show that ex post holding-period returns cannot be used to extract expected default information.

An alternative model of expected default rates was also compared with actual default experience and found to perform as well as the risk-neutral model. We conclude either that there is systematic mispricing of low-rated corporate bonds by investors or that the risk-neutral model derived herein cannot fully capture the market's assessment of the probability of default on these securities. Finally, the response of the default premium to macroeconomic surprises appears to lie below statistical significance, with deviations from inflation expectations having the greatest influence.

Future endeavors in this area will require the accumulation of better (and more detailed) measures of corporate bond returns. The construction of a standardized data base for corporate bond prices, modeled after the Center for Research on Security Prices' files (adjusting for the lack of depth in this market), would provide the greatest benefits for further study in this field. In addition, the accumulation of a longer sample period would improve the ability of researchers to identify the underlying relationships determining corporate bond yields.

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