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THE DEFAULT PREMIUM AND CORPORATE BOND EXPERIENCE

By Jerome S. Fons

Jerome S. Fons is an economist at the Federal Reserve Bank of Cleveland. The author would like to thank Jim Balazsy for excellent research assistance, Bill Gavin and Ross Starr for helpful comments, and the participants of the Federal Reserve System's Financial Analysis Committee Meeting at the Board of Governors in November 1985.

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I. Introduction

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 past default experience to explain differential rates of return on low-rated bonds.

In this study we develop a risk-neutral model of the expected probability of default for low-grade bonds as a function of the additional required rate of return on these instruments over default-free bonds. Within this framework, securities are priced as functions of the first moment of the return distribution. The techniques are used to express this pricing relationship in terms of the yields to maturity of risky bonds as well as their holding period returns. We then compare the default rates implied in corporate bond yields to a series based on recent corporate bond default experience. We also discuss why implied default rates cannot be obtained from measured holding period returns. Finally, attention is paid to macroeconomic indicators of expected default rates.

In an early paper on the subject of default risk premia, Fisher (1959) 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 failure to pay any coupon or principal payments when due) and on the "marketability" of the bond. In addition, modern approaches acknowledge the influence 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.

As Jones, Mason and Rosenfeld (1984) pointed out, studies that attempt to explain corporate bond prices can be identified as being either "macro" in nature, in that relative bond prices are modeled as being "functions of the supply and demand of various assets, and/or the position of the economy in the business cycle," or as being "micro" in that relative prices are modeled as a function of firm specific characteristics. The approach taken in this paper is macro; that is, that aggregate returns on a sample of bonds are used to infer average default probabilities for the population of bonds with similar characteristics.

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 assigned rating gives, in a single measure, the rating agency's estimate of the issue's probability of default.

Studies that have attempted to measure the importance of rating changes on bond price movements tend to differ in their conclusions. Hettenhouse and Satoris (1976) as well as Weinstein (1977) conclude that market participants incorporate new information before a rerating. On the other hand, Ederington, Yawitz, and Roberts (1984) 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) and/or BBB- or higher (from Standard & Poor's), while speculative grade bonds consist of issues with ratings below these, as well as corporate bonds that are nonrated.

Section II contains a discussion of the construction of the default rate series used in this paper. In section III 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 IV repeats this exercise for holding period returns and discusses the complications of using holding period returns. Section V investigates the relationship between changes in expected corporate default rates and certain macroeconomic measures. In section VI we present a summary of the paper and some closing remarks.

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Economists have tracked the performance of corporate debt beginning with a study by W.B. Hickman (1958). His and almost every subsequent study defines the rate of default as the value of issues defaulting during the period examined divided by the value of bonds outstanding during some part of the period (usually the beginning). Altman and Nammacher (1985) (A&N hereafter) argue that, since almost all 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.

In A&N, and in this study, only publicly held, straight (non-convertible) 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.

A complication arises in the construction of a measure of the default rate for bonds of a given rating: by the time an issue defaults, it has usually descended in rating until it has reached the rating D (for Default). We, therefore, limit our analysis to the performance of all low-rated corporate debt. 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 12 months and dividing by outstanding low-rated bonds six months earlier. This is essentially a 12-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 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 are based on the assumption that defaults result in a total loss to bondholders. In fact, A&N find that defaulting bonds continue to trade at 41 percent of par within one month following the default. Therefore, the actual "loss rate" is somewhat lower than our default rate estimates.

III. Default Rates and Yields to Maturity

Our theoretical model is based on the pioneering work of Bierman and Hass (1975), with subsequent extensions by Yawitz (1977). The proposed model is in the same spirit as that used by Yawitz, Maloney, and Ederington (1983) to model yield spreads in the municipal bond market on the basis of differing default probabilities and tax effects.[1]

Most asset-pricing models are based upon the first and second moments of the return distribution. With risk-neutral preferences, on the other hand, agents consider only the first moments of the distributions of return: the security's expected return completely determines its market price. This framework facilitates the construction of a certainty-equivalence 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 $(1-P)$. 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. Algebraically:

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

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.

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

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

$$= \frac{1}{(1+r)^{N}} - \frac{C\{1-(1+r)^{N}\}}{r(1+r)^{N}} .$$

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 involve time-subscripts for the variable P, so that 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 in the numerators of the left hand side of (1). The product of the P's from the initial date to the date preceeding the payment date would be multiplied by 1 minus the expected payment rate in the relevant period for the second term. Of course, 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 use of a single, constant measure of P can be interpreted as an "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[1] 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: 1) more than $25 million in principal outstanding (assuring adequate marketability), 2) ratings below Baa3/BBB-, or not rated but of lower than Baa3/BBB- quality, 3) a coupon of 10 percent or more, and 4) longer than 10 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.

Complications arise in the analysis because of several uncontrolled factors. First, 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 fact that the low-rated sample consists of high-coupon issues, increases the likelihood that they would be called if interest rates fall significantly (or if the firm's financial condition warrants an up-grading). This and other factors imply that there is no comparable high-grade index that will exactly match each of the characteristics (apart from default risk) of the low-rated sample.

As a compromise, we chose to use Salomon Brothers' New Medium Term

Industrials index for 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 market that are rated Aaa and will mature in 10 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 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 15 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 different tax treatment. In addition, the sheer 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 a factor that is tied to the default experience of corporate bonds. The use of a weighted average of bond returns causes the influence of the idiosyncratic variations to cancel one another. Hickman (1958, 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.

8. Comparison of Actual and Implied Default Rates

A numeric solution program was employed to solve (2) for the expected "payment rate", P, given supplied values for r, I, μ, C, and N, at the end of each month t. This is a measure of the cross-sectional average of implied expected payment rates, based on the yields of a cross-section of low-rated bonds. A problem emerges, however, because of the aggregation procedures used.

Let us assume that P is an implicit function of r (with i, C, μ, and N held fixed). Since (2) cannot be solved explicitly for P, a computer simulation was employed to graph the implicit function with restrictions on the values of the other variables and an assumption about the relationship between C and r. Figure 2 is a graph of the simulation. Note that when the payment rate P is' equal to 1, the risky rate takes on the supplied value of the riskless rate (10 percent here). The relationship between P and r is shown to be convex in the relevant range. Jensen's inequality, therefore, 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.

A 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, "actual" default rates so well is surprising, given that the implied rate represents an average of expected future default rates. This behavior indicates a degree of myopia on the part of market participants. 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, one may gain additional insight 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 2. These regressions indicate that there is some connection between measured implied default rates (based on risk-neutral preferences) and the two actual default rate series. The adjusted R-squares of 10.2 percent 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. The large t-statistics for the constant terms cause us to reject the null hypothesis that the market's (risk-neutral) estimate of default rates equals actual default rate experience. In fact,'. evidence suggests that market prices imply default rates that exceed actual default rates by roughly 5 percentage points.

IV. 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 (pro-rated 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:

$$(3) \qquad H_t = \frac{B_t - B_{t-1} + C_t}{B_{t-1}}$$

The corresponding gross return to the holder of a default-prone bond with price B^*_i and coupon C^*_i in period i is represented by:

$$(4) \qquad h_t = \frac{B^*_t - B^*_{t-1} + C^*_t}{B^*_{t-1}} .$$

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

Now let m_t be the percieved 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 likelihood that the firm will not default over a given 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:

$$(5) \qquad E(h_t) = \frac{m_t(B^*_t + C^*_t) - B^*_{t-1} + (1-m_t)\mu B^*_{t-1}}{B^*_{t-1}} .$$

For the certain case in which m_t equals 1, $E(h_t)$ will equal h_t, whereas 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 return on the default-prone and the default-free bond will be equal. Setting the right-hand side of (5) equal to H_t and using equation (4), we have:

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

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 expected default rate embodied in the 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. 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 (1984) based on the price movements and coupon payments of the bonds used in Salomon Brother's Low-Rated (or High Yield) Bond Index (discussed above). The "merged" 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 Brother's High Grade Index for total rate-of-return found in their Analytical Record of Yields and Yield Spreads (up to 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 in Blume and Keim (1984).

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. That is, the measured annual holding period return at each date is based on the returns to bond holders who sold a security purchased one year earlier (and collected coupon payments for the period). With these measures of return, (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 historic 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 2, we present the regressions of the measured performance rates (expressed in annual terms and based on one- and 12-month holding period yields) on the two 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 supports the observation of a 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 12-month holding period yields suggest that, on average, holders of low-rated bonds realized significant holding period gains relative to their high-grade counterparts.

V. efault tions and croe Measur

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 (1975) 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 (1971), based on data collected by the University of Michigan Survey Research Center, which acts as a proxy for consumer sentiment. This factor was also used by Cook and Hendershott (1978), 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 contractual 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 will affect 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 are the Board of Governors of the Federal Reserve'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 to us. The size of the market for low-rated bonds approached significance only towards the end of the 1970s. The identification of long-run relationships is, thus, seriously hampered. Secondly, in the sample period of this study, the overall inflation rate was, on average, falling, after a long period of accelerating inflation. The effects 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 the behavior exhibited here.

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 about the economy (in addition to firm-specific factors) 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 rates, obtained from differential yields to maturity (1-P), 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 3, 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. However, no variable enters significantly in either regression at the 95 percent confidence level. The low adjusted R-squares also leads 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 3, these results suggest that, though insignificant at the 95 percent confidence level, surprises in inflation are most closely related (positively) to performance rates. It must be the case that firm-specific factors dominate the formation of default expectations to the point that surprises in macroeconomic measures are poor predictors of overall quality spreads.

VI. Summary & Conclusions

This paper represents the first effort to tie together the. differential returns required by holders of low-rated corporate bonds and the actual default experience of these issues. A model of the behavior of low-rated bond pricing was developed in a risk-neutral setting. We applied the model to the observed returns of a sample of bonds and compared the default rates implied in these returns to the default experience of low-rated debt. We conclude that the default rates implied in corporate bond returns exceed those experienced in recent years. In this sense, holders of well-diversified portfolios of low-rated corporate bonds are rewarded for bearing default risks. It was also shown that measured holding period returns cannot be used to extract implied default rates.

Finally, we examined the relationship between a set of macroeconomic variables and expected measures of default and performance rates. We conclude that expected corporate default rates are not related to any of the macroeconomic variables at the 5 percent critical level, although expected default rates were most strongly related to surprises in inflation measures and actual default rates. Surprises in output proxies appear to have less of a relationship to expected default rates.

Further study in this area will require the accumulation of better (and more detailed) measures of corporate bond returns. The construction of a standardized data base, modeled after the Center for Research on Security Prices (or CRISP) tapes, would most benefit future endeavors in this field. In addition, a longer sample period would increase our understanding of both the pricing of default risk and the relationship between expected default rates and macroeconomic activity.

Footnotes

1. Yawitz, Maloney, and Ederington (1983) do not compare their estimates of default rates in the municipal market with actual rates.

2. If one approximates the finite-maturity coupon bond with a perpetuity--multiply 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 let N approach infinity--then (2) becomes:

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

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 Brother's 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) were bonds rated single B. This index, therefore, represents the average returns of the riskiest corporate bonds.

4. Coupon payments received from Treasury securities are currently exempt from state and local income taxes. Ibbotson and Sinquefield's (1982) measured default premium, constructed by subtracting the <u>ex-post</u> holding returns on

Treasury bonds from AAA/Aaa rated corporates, may mostly reflect this tax differential.

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

$$1 + h_t = (1 + H_t)/m_t \quad .$$

6. The partial derivative of $(1-m_t)$ with respect to h_t is:

$$\{H_t + (1-\mu)\}/\{h_t + (1-\mu)\}^2 \quad ,$$

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 Altman's estimates, $(\mu-1)$ equals -0.59, implying that this condition will be met under most circumstances.

7. See Blume and Keim (1984) for a description of this series.

Table 1 Summary of Measured and Constructed Series

	Mean	Standard deviation	Minimum (date)	Maximum (date)
12/79 through 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† (I-month)	0.01857	0.03281	0.00000 (23 points)	0.19504 (4/82)
ADR (12-month)	0.0 1776	0.01276	0.00045 (10/81)	0.04756 (11/82)
1/80 through 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)† (fr. 1-month HPY)	0.00732	0.43032	-1.3765 (3/80)	0.7787 (12/81)
12/80 through 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) (fr. 12-month HPY)	0.08858	0.06637	-0.1009 (12/82)	0.2164 (10/83)

† Expressed as an annual rate.

Table 2 Implied Default and Performance Rates on Actual and Smoothed Default Rates

Dependent variable	Const.	ADR	SADR	$\bar{R}^2$	DW
12/79-12/85					
(1-P)	0.0504 (17.82)	-0.0058 (-0.35)		0.102	1.90
(1-P)	0.0479 (12.43)		0.1413 (1.00)	0.111	1.89
1/80-6/84					
(1-m) (fr. I-month HPY)	0.0108 (0.18)	-0.2606 (-0.15)		-0.019	1.99
12/80-6/84					
(1-m) (fr. 12-month HPY)	0.0926 (3.93)	-0.2586 (-1.34)		0.013	2.08
(1-m) (fr. 12 month HPY)	0.1320 (5.51)		-2.207 (-2.35)	0.084	2.01

Note: All regressions were run using the Cochrane-Orcutt procedure for first-order serial correlation. The reported Durbin-Watson statistics are less powerful when the serial adjustment technique is used. The t-statistics are reported in parentheses.

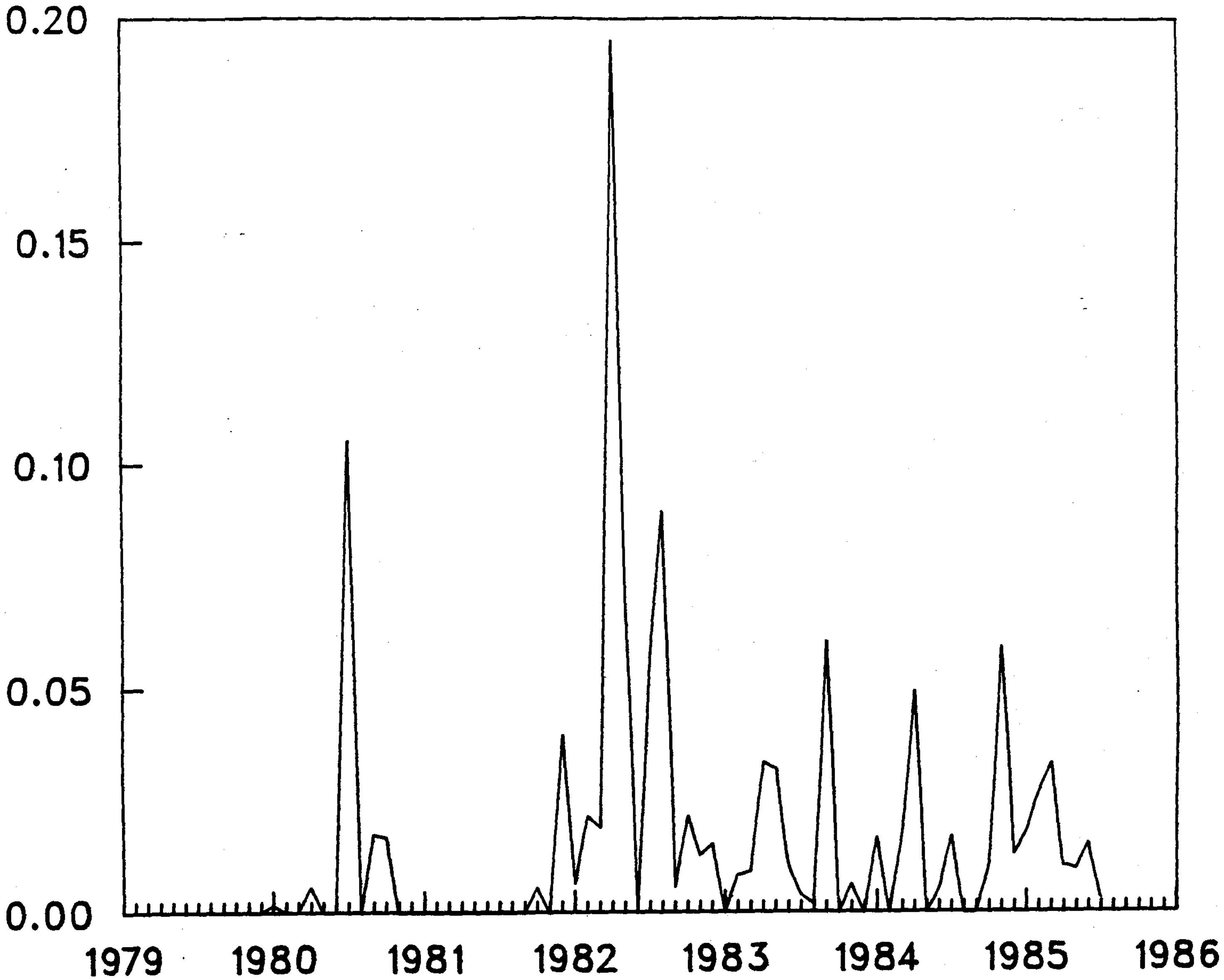
Table 3 Implied Default and Performance Rates on Actual Default Rates and Macroeconomic Surprises

(Dependent Variable First-Differenced)

Dependent variable	Const.	ADR	Infl.	Ind.Prod.	Unemp.	$\bar{R}^2$	DW
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)		

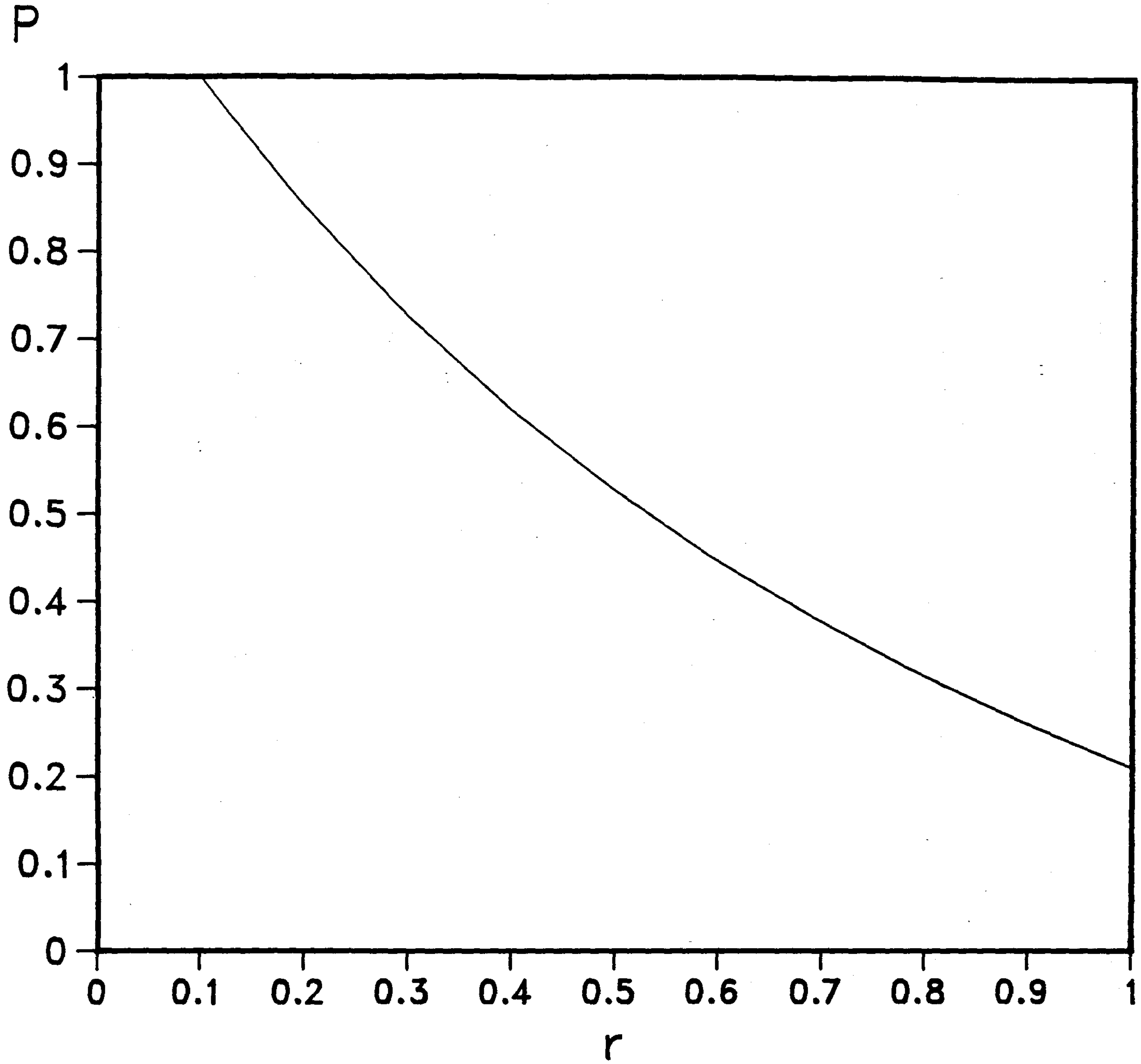
† Run using the Cochrane-Orcutt procedure for first-order serial correlation. The t-statistics are reported in parentheses.

Figure 1: Actual Default Rate Series (in Annual Rates).



Source: Altman and Nammacher (1985), and Standard & Poor's Bond Guide.

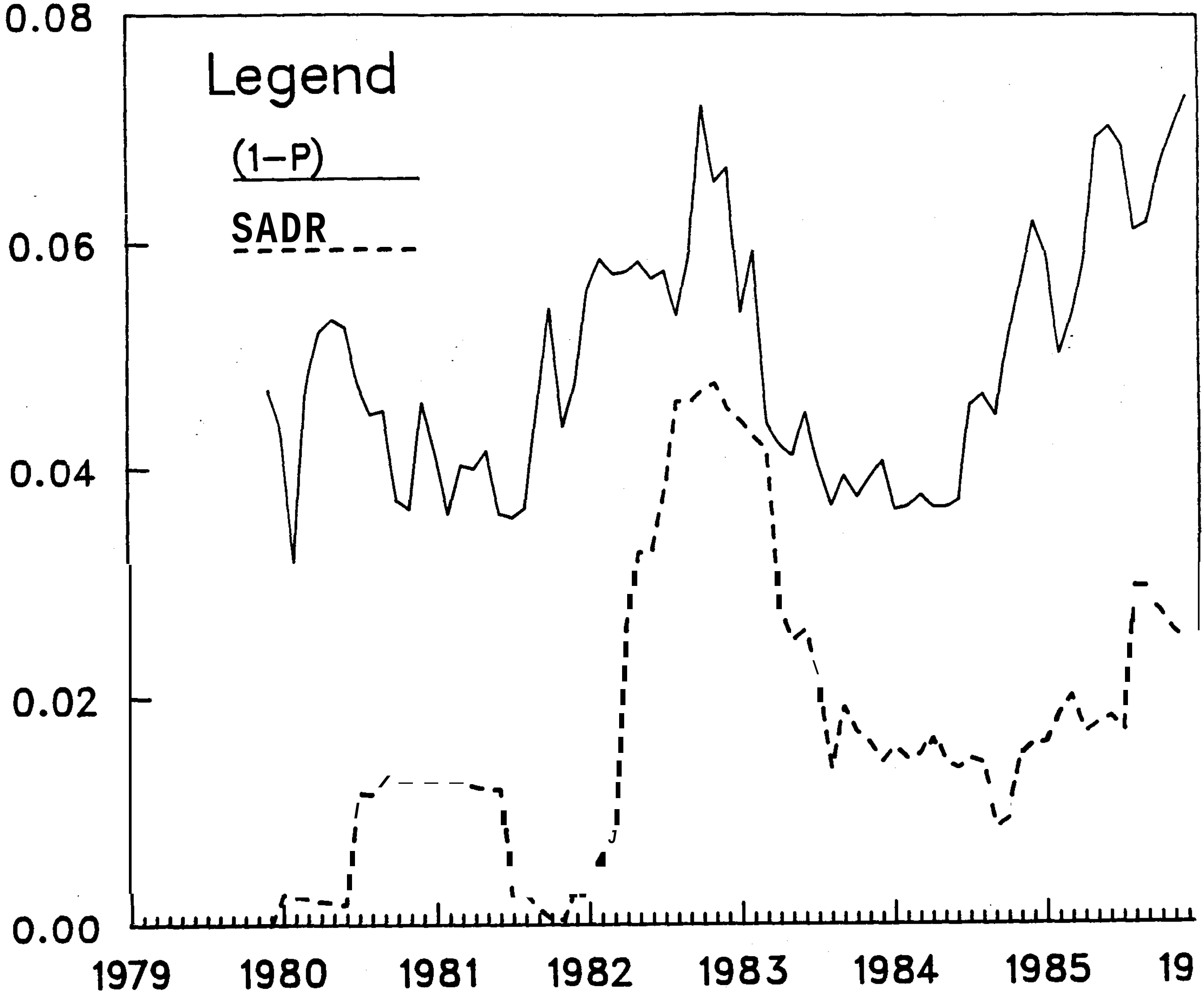
Figure 2: Plot of r against P (with μ=.41, i=.1, C=.913r†, and N=14).



†: The partial adjustment for coupon rates is based on the fact that corporate bonds were trading, on average, at 91.3 percent of par value.

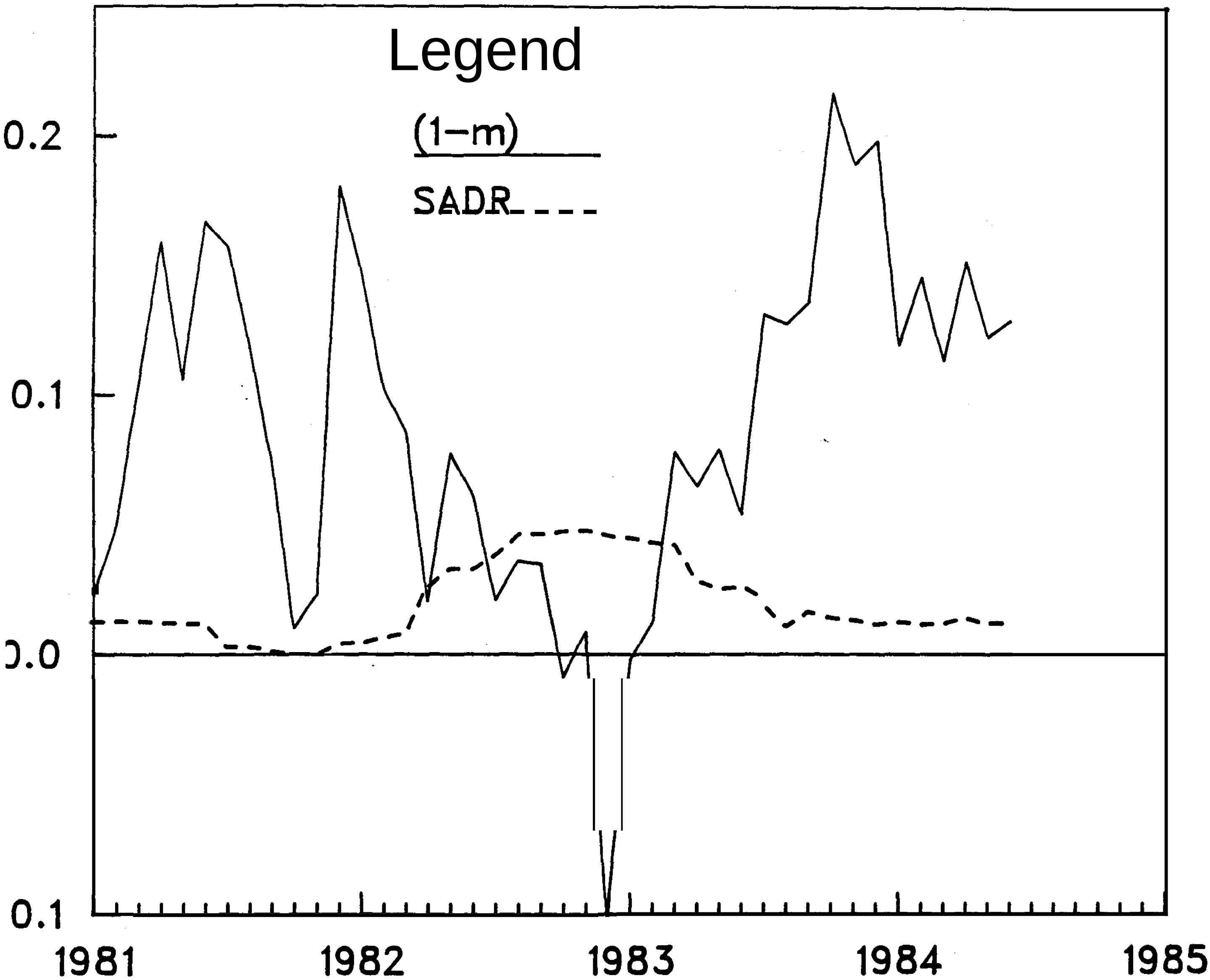
Source: See text.

Figure 3: Time Series of (1-P) and Smoothed Actual Default Rates.



Source: See text.

Figure 4: Time Series Plot of (1-m), Constructed from Annual Holding Period Yields and Smoothed Actual Default Rates.



Source: See text.

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