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THE RISK-FREE U.S. BOND RATE: ERRORS IN CONSTRUCTION AND USE IN ECONOMETRIC WORK

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I. Introduction

Observed differentials among yield series for different types of long-term instruments--U.S. government bonds, municipal bonds, corporate bonds and residential mortgages--vary considerably over time. Many factors can contribute to observed long-term yield spreads, the most important of which are "technical" factors that relate to differences in the particular characteristics of instruments or in the investors that purchase them. These include the tax status of various types of income accruing to the security and the degree or certainty associated with that income. Long-term yield spreads might also be affected by relative security supplies and relatively exogenous demands, e.g., Federal agency demands for residential mortgages, particularly if institutional constraints on permissible yields or on the various sectors that purchase the long-term instruments exist. Failure to consider the effects of all of these factors has frequently created misunderstanding both in the financial press and in academia about the causes of observed yield spreads. For example, attempts have been made to measure the impact on long-term yield spreads of individual factors--such as default risk or relative security supplies--by comparing yield series without proper regard for the concurrent impact of other technical and/or fundamental factors.

This paper deals exclusively with long-term corporate and U.S. government bond yields. The most widely used series are Salomon Brother's

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Aa deferred call new issue utility yield and the Federal Reserve Bulletin's average yield on bonds maturing or callable in 10 years or more.[1] The spread between these series is shown as the solid line in Chart 1. (The dashed line will be discussed later.) The spread has moved over a wide range, rising sharply from 40 basis points in late 1965 to 235 basis points in the second quarter of 1970, subsequently falling to 140 basis points in early 1973, and then rising to almost 300 basis points in the third quarter of 1974. The central question addressed in this paper is what have been the relative contributions of taxes, risk, and relative security supplies as determinants of these movements?

The general procedure used to deal with this question is as follows. First, direct adjustments are made to the yield series to account for some factors affecting them differently. These include the unusual tax treatment of some of the income from U.S. government bonds and the impact of the failure of Con Edison to pay a dividend in 1974 on the probability investors attached to receiving the quoted return on utility bonds. Second, proxies are specified to capture the impact of call risk, default risk, and relative security supplies on the spread between the adjusted yield series. The adjusted yield spread is then regressed on these proxies and the estimated coefficients are used to compute the impact of these factors. Section II of the paper discusses technical factors that affect the yield spread through their influence on the U.S. bond yield series and surveys several studies that have used U.S. bond yield series without proper consideration

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[1]The yield series used throughout the paper are quarterly averages of monthly data. Series from the Treasury Bulletin are for the last day of the month while series from Salomon Brothers' are for the first day of the following month. The Federal Reserve Bulletin's U.S. yield series is a monthly average of daily figures.

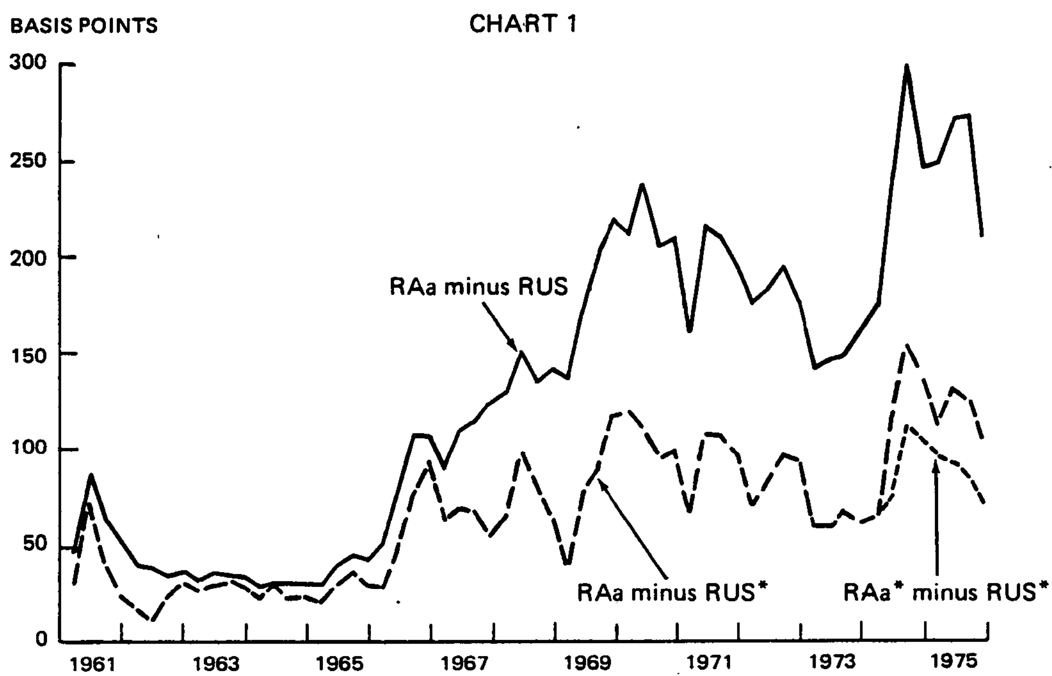

CHART 1. The Spread between Salomon Brothers' Aa Utility and the Federal Reserve's Average U. S. Yield Series and the Spread between the Aa Utility and New Issue Equivalent U. S. Yield Series

for the possible impact of technical factors on the movement of the series. Section III constructs a "new issue equivalent" U.S. bond yield series that attempts to eliminate some of the technical factors that contribute to the spread between corporate and U.S. bond yield series. Different types of risk that affect the spread through their impact on the corporate bond yield series are discussed in Section IV. Section V presents empirical results.

II. Technical Factors Influencing U.S. Yield Series

Virtually all observed yield series are before-tax yields-to-maturity (or to the earliest call date in some cases) calculated under the assumption that the future cash flows associated with owning a security are known with certainty. In this framework the yield of a security is the discount rate that equates the price of the security to the present value of the before-tax future promised cash flows. However, the relevant yield to investors is, abstracting from risk considerations, the discount rate that equates the price to the present value of the future after-tax promised returns. Because income that accrues from long-term securities is alternatively subject to the relevant marginal income tax rate, the capital gains tax rate or, in some cases, no tax rate, a wide range of observed before-tax yields can provide the same after-tax yield.

Two major technical factors have influenced the movement of the average U.S. yield series relative to the movement of new issue yield series. No new U.S. bonds with a maturity of 20 years or greater were issued from May 1963 through January 1973. Consequently, as a result of the rising interest rate trend over that period, all outstanding U.S. bonds became discount bonds. Interest income on discount bonds is taxed at the relevant marginal income tax rate, while the difference between the purchase price and the redemption value is taxed at the lower long-term capital gains tax rate. Discount bonds have the secondary advantage that a larger part of the tax is collected at a later date.[2] For these reasons investors are willing to accept a lower before-tax yield on discount bonds than on newly-issued bonds that are otherwise comparable in all respects.

The second factor is that virtually all U.S. bonds issued prior to 1971 are redeemable at par for estate tax purposes. U.S. bonds that have this feature are widely called "flower bonds." Since these flower bonds are also discount bonds, they offer the potential of a rapid capital gain. Furthermore, prior to changes in the tax law made in the Tax Reform Act of 1976, the gain was free from capital gains taxation.[3] (The capital gain did, however, enter into the value of the estate and was therefore subject to estate taxes.) The combination of the flower bond stipulation and the tax treatment associated with the capital gain greatly reduced the before-tax yield necessary to provide a given after-tax yield to the decedent's estate. The most sought after flower bonds have been those with the lowest coupons, selling at the greatest discounts.

A third technical factor that can influence the movement of the U.S. average yield series relative to other yield series results from the fact that the U.S. series is an average for bonds with a wide range of maturities,

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[2]Robichek and Niebuhr [19] discuss these two factors.

[3]The Tax Reform Act of 1976 changed the tax basis for inherited property to its cost to the decedent. For certain property, such as flower bonds, beneficiaries may increase the cost basis to the fair market value of the property on December 31, 1976. Consequently, under the new law, the difference between the par value of the flower bond used for estate tax purposes and the original cost or market value at the end of 1976, whichever is greater, is subject to capital gains taxation.

some as low as 10 years. If the average maturity of the series changes substantially over time, as one would expect given the absence of new issues, it can result in a movement of the series solely due to a movement along the yield curve. In fact, from January 1964 to January 1974, for example, the average maturity of the U.S. yield series fell from 24.4 to 18.2 years.[4]

III. A Survey of Studies Using Observed U.S. Yield Series

In spite of the very significant impact of the technical factors on observed U.S. bond yield series, these series have been widely used in three types of studies.[5] The first are studies of the impact of risk premiums on yield spreads (or yield ratios). Because Treasury securities are default free, the spread between the yield on any other security and the yield on Treasuries depends on the probability of default on the non-Treasury security. However, a number of researchers have overemphasized default-risk as a determinant of yield spreads to the exclusion of other factors and in doing so have drawn some questionable implications from their empirical results. Brenner [2], for example, concludes that a main determinant of spreads between observed before-tax yield series on mortgages and Treasuries,

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[4]It should be noted that Salomon Brothers has yield series that effectively deal with two of the three problems discussed above. Their yield series for fixed U.S. maturities (i.e., 10, 20, 30 years) are read from monthly yield curves. When there is a choice of coupons, the curves follow the yields of higher coupon issues in the longer maturities. The higher coupon (4 to 4-1/4 percent) bonds were largely unaffected by the estate tax effect in the period when no new bonds were issued from 1963 through 1973. The Salomon Brothers' series were, however, heavily influenced by the capital gains tax effect in those years.

[5]The use of U.S. bond yield series involves only minor problems prior to the mid-1960's, because there was only a small differential between current yields and coupons on seasoned U.S. bonds. In each of the studies cited, however, the series is used into the late 1960's, or beyond, when the tax-related problems become severe.

municipals and Treasuries, and corporates and Treasuries is differences in risk as measured by the differences in the variance of the yields. An important factor contributing to both the relatively small variance of the U.S. rate and the relatively low level of the rate, however, was the dampened movement of the before-tax rate resulting from the capital gains tax effect (Salomon Brothers' 20-year U.S. rate is used, thereby eliminating estate tax problems). Consequently, a large part of both the movement in the spread between the yield on an alternative long-term bond and the yield on U.S. bonds--Brenner's dependent variable--and the difference between the variance of the two yields--Brenner's independent variable--is due to the same underlying cause.

Bisignano [1] assumes that the spread between the corporate (apparently Moody's Aaa seasoned series) and the U.S. average series is a measure of the risk associated with Aaa-rated bonds.[6] Because this spread rose sharply in the late 1960's and remained high in the 1970's, he concludes that the risk premium between high quality corporates and U.S. governments has risen sharply. He further concludes that the market has been inefficient in letting this "risk premium" persist. The increased differential is, however, largely attributable to the impact, noted above, of technical factors on the U.S. yield series and, thus, may not be evidence of inefficient markets.

Perhaps the most interesting risk-related problem resulting from the usage of observed U.S. yield series is found in Kichline, Laub and Stevens [15], the study on which the Federal Reserve Board's Aaa newly issued and recently

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[6]The problem with using the spread between Moody's Aaa rate and the U.S. average rate can be seen immediately by comparing it to the spread between Salomon Brothers' Aaa new issue industrial yield series and 20-year high coupon U.S. yield series. The former spread is 185 basis points in 1975, while the latter is only 66 basis points.

offered Aaa utility bond yield series is based. In this case the technical factors plaguing the U.S. series are built into the Board's utility series because these series are constructed using estimated historical relationships that involve the "observed yield on a long-term, risk-free U.S. government bond." Kichline, Laub and Stevens construct a 20-year Aaa-rated 5-year call utility yield series for periods when no such bonds are offered by using data on other (lower-rated, nonutility, etc.) new issues. The adjustment procedure converts the yield on an A-rated new utility issue, for example, by using the implicit relationship:

$$\text{(1)} \quad RA - RAaa = \hat{a} + \hat{b}\,(RAaa - RUS),$$

where RA is the yield on the A-rated utility, RAaa is the yield on the Aaa-rated utility, RUS is the observed yield on the U.S. government bond, and $\hat{a}$ and $\hat{b}$ are coefficients estimated from data in the January 1960 through February 1972 period when both A and Aaa utility bonds were issued. RUS is too low throughout the second half of the period because it is for low coupon, discount bonds; RAaa, however, is for new issue bonds. Consequently, the (RAaa - RUS) spread is too large and $\hat{b}$ is biased downward.

Equation (1) can be rewritten as

$$\text{(1)'} \quad RAaa = \frac{-\hat{a}}{1+\hat{b}} + \frac{RA}{1+\hat{b}} + \frac{\hat{b}}{1+\hat{b}}\ RUS.$$

As long as the RUS series used in equation (1)' continues to be for low coupon bonds, the relationship would be roughly accurate because the impact of the biases of $\hat{b}$ and RUS on the estimated RAaa would be offsetting. Once RUS is switched to a high coupon bond, however, the estimated RAaa using equation (1)' will be too high. Furthermore, because the weight given RUS in equation (1)' is biased downward, the error in the estimate will become more severe as risk premiums rise. That is, if RA and RUS are relatively close, this bias will be less significant than if RA rises relative to RUS. In the latter case we might expect the error built into the estimated RAaa series to rise.

Comparison of the Board's Aaa, 5-year call utility yield series and Salomon Brothers' Aaa, 5-year call utility yield series supports the two contentions made above. The two series move together very closely through early 1973, the year when high coupon long-term U.S. bonds were again issued. Subsequently, the Board series increases relative to the Salomon Brothers series, rising to 45 basis points in the third quarter of 1974. Thus, while the average spread between the two series in 1970 through 1972 was only 1/3 of a basis point, the average spread from the beginning of 1974 through the third quarter of 1975 was 31 basis points. In 1975 the Board's equation was reestimated using data from 1973 through late 1975. Since then the Board's estimated series and Salomon Brothers' series have been quite close on average.

The second area in which U.S. yield series have been misused is the term structure of interest rates. Hambor and Weintraub [11] and Terrell and Frazier [21], for example, both attempt to determine the impact of relative security supplies on the term structure of Treasury securities by relating the ratio of the Treasury bill rate and the average long-term U.S. yield series to relative stocks of short- and long-term U.S. securities. Because no new U.S. bonds were issued over a large part of the period studied, however, the average long-term U.S. yield series is heavily influenced by the yields on low coupon, discount and flower bonds. Consequently, the relative supply of long- to short-term U.S. securities declined at the same time that the tax factors were exerting downward pressure on the average long-term U.S.

series. This generates a correlation between relative stocks and observed relative yields, even if there is none between relative stocks and after-tax relative yields.

Dobson [7] uses the expectations hypothesis as embodied in the observed pattern of (Salomon Brothers) U.S. yields to estimate risk premiums for various maturities of U.S. bonds. Over much of the period he considers (1954-74), however, the slope of the U.S. yield curve was biased downward due to the impact of the tax factors on the longer-term yield series. Kichline, Laub and Stevens [15] use the before-tax U.S. yield curve and the expectations hypothesis to derive a series of forward rates. The pattern of forward rates derived using such a procedure will, during part of the period, be faulty because technical factors are creating a divergence between the slopes of the before-tax and after-tax yield curves; consequently, interest rate expectations implied by the before-tax yield curve will not be the same as those implied by the after-tax yield curve.

A third type of study using the long-term average U.S. yield series (or Salomon Brothers' U.S. series) is studies of supply and demand for financial claims and the impact of relative security supplies on long-term yield spreads. In view of the technical factors influencing before-tax U.S. yields, comparisons of the U.S. yield series (prior to 1973) with new issue yield series on other instruments can be misleading. Before-tax yield differentials might be moving quite differently than after-tax differentials. Pesando [17] and Ostas [16] are examples of studies that use the average of U.S. yield series, in comparison with other yield series, to explain financial behavior.

From the viewpoint of this paper, the most important study is that of Fair and Malkiel [9]. They compare the level of the relative stocks of utilities and U.S. government bonds to the level of the spread between Salomon Brothers' utility and U.S. bond yield series. Use of the U.S. yield series introduces the same bias indicated in the studies cited above that attempted to measure the impact of the relative stock of short- and long-term U.S. securities on their relative yields. Over a long period in which the Fair-Malkiel regressions were estimated (1961 through mid-1969), the U.S. yield series was low relative to new issue corporate yield series because of the capital gains tax effect. During the same period, due to the lack of new U.S. bond issues, the relative supply of U.S. bonds was declining. Consequently, at least part of the observed relation between relative corporate and U.S. supplies and relative corporate and U.S. yields was due to technical, not fundamental, factors.[7] Fair and Malkiel conclude that their results "strongly support the theory that yield differentials of alternative bond instruments of the same maturity are influenced by stocks of bonds outstanding. . ." A major goal of this paper is to determine whether this conclusion still holds for the spread between corporate and U.S. bond yields after technical factors are taken into account.

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[7]Fair and Malkiel [9] deal with this problem in one of their regressions by using the spread between the U.S. bond rate and a low coupon corporate bond rate. They also compare the spread between Moody industrial and utility yields to the relative stocks of industrial and utilities. In all cases their results support the conclusion that relative security supplies affect relative yields. The measured impact of relative supplies on the U.S. corporate yield spread when the low coupon bond rate is used, however, is only about 40 percent of the measured impact when the new issue corporate rate is used.

IV. Construction of a New Issue Equivalent U.S. Bond Yield Series

We have constructed a U.S. bond yield series designed to eliminate, or at least minimize, the technical factors affecting U.S. bond yield series that create artificial differences between these yield series and new issue yield series for other sectors, e.g., the corporate sector.[8] The series, hereafter labeled RUS*, was constructed by choosing selected U.S. bond issues and converting their yields into "new issue equivalent" yields. First, after making marginal and capital gains tax rate assumptions to be discussed below, after-tax yields for these issues were calculated. Second, new issue yields that provided equivalent after-tax yields were computed. The issues selected to construct the new issue equivalent yield series, RUS*, were chosen according to the following rules:

1. The maturity of a bond issue used in the series should be 20 years or more. If the issue is callable and selling at a premium, then the call date should be 20 years or more.

2. The highest coupon issue available should be used so as to eliminate all issues whose yields are affected by the estate-tax provision from consideration.

The adjustment procedure is designed only to deal with the capital gains tax effect. It will be argued below that at every point in time since 1961 (the beginning of our estimation period) the yields of the highest coupon issues have been unaffected by the estate tax provision. Hence, the second rule effectively eliminates the flower bond tax effect.

The maturity requirement embodied in the first rule is used because differentials among yields on instruments equal to or greater than 20 years tend to be small and vary little over time. For instance, when there are

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[8] Robichek and Niebuhr [19, p. 1090] proposed such a calculation years ago.

current coupon, or close to current coupon, U.S. bonds in existence--and yields can consequently be reasonably compared across maturities--the differential between 20 and 10 year maturity yields is large and variable, while the difference between 30 and 20 year maturity yields is much smaller and more stable. In 1973, 1974 and 1975, for example, the yield spreads between Salomon Brothers' 20 and 10 year U.S. bond rates were 24, 60 and 62 basis points, respectively, while the differentials between Salomon Brothers' 30 and 20 year U.S. rates were only 2, 4 and 19 basis points, respectively.

The U.S. bond issues included in the composition of the Federal Reserve Bulletin's long-term average U.S. bond yield series since 1961 are shown in an appendix with their coupons, maturities and offering dates. Each issue is judged with respect to the two rules above and the issues used to construct RUS* are indicated. The appendix also goes into greater detail on the construction of our series. Due to the absence of alternative acceptable choices, the maturity rule was violated, but only slightly, in late 1972 and in the first part of 1973.

The spread between Salomon Brothers' Aa utility yield series, RAa, and RUS* is the second series (the dashed one) shown in Chart 1. The spread between RAa and RUS* rises to a level of 120 basis points in the first quarter of 1970, but is still only 1/2 the level of the spread between RAa and RUS at the same time. Consequently, tax factors accounted for roughly one-half of the observed rise in the spread between new issue corporate and seasoned U.S. yields in the second half of the 1960's,[9] and the unadjusted U.S. yield

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[9]Cook [5] suggested this magnitude.

series has, on average, been more than a full percentage point below the fully-taxed, new issue equivalent yield series in the 1970-75 period.[10]

Two important assumptions underlying the construction of the new issue equivalent U.S. bond yield series should be discussed at this point. The first is the assumption that the yield of the 4-1/4's of 87-92, which is used in the construction of the series from August 1962 through January 1973, was not affected by its estate-tax provision over that period.[11] This assumption can be defended on two grounds. First, data on year-end amounts of flower bonds outstanding from the Treasury Bulletin indicate that there was very little demand for the 4-1/4's of 87-92 for estate tax payment purposes through 1972. The net decline in the amount outstanding of an issue from year to year is a measure of the amount retired for estate tax purposes. The decline in the amount outstanding of the 4-1/4's of 87-92 was negligible until 1973. For lower coupon bonds such as the 3's of 95 the amount outstanding declined steadily beginning in the mid-1960's. Further support for the assumption comes from a comparison of the yield of the 4-14/'s of 87-92 with the yields of high coupon bonds issued in the first half of 1973. When the 6-3/4's of 93 were issued in early 1973, the spread between their yield and that of the 4-1/4's of 87-92 could be completely explained by the capital gains effect, indicating that the estate tax provision was not putting additional downward pressure on the yield of the 4-1/4's of 87-92 up to that time.

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[10]Because the U.S. series has traditionally been the discount rate used in litigation cases to determine the present value of income lost due to death or injury, these awards have been significantly overstated.

[11]The growing impact of the estate tax provision on low coupon bond yields in the 1973-76 period is discussed in Cook [4].

The second important assumption underlying the construction of the new issue equivalent yield series is the appropriate marginal and capital gains tax rates used to calculate after-tax yields. The assumption employed throughout the period examined is that these rates are equal to the prevailing permanent corporate income and capital gains tax rates. (The impact of the imposition and removal of the surcharge on the tax rates was ignored.) Attempts to justify this assumption can proceed from two directions: ex ante or ex post. On an ex ante basis it can be supported through 1969 because numerous sectors in the market--savings and loan associations, commercial banks, mutual savings banks--were subject to corporate income and capital gains tax rates. The Tax Reform Act of 1969 modified the treatment of capital gains for banks and the thrift institutions, however, by requiring them to treat gains and losses on securities acquired after July 1969 as ordinary income. Consequently, it is more difficult to justify the assumption since then. Table I shows new issue equivalent yields for the 4-1/4's of 87-92 on the basis of three different tax rate assumptions. The first are the corporate tax rates used in the construction of RUS*, the second are the rates applicable to an individual in a 40 percent marginal tax bracket, and the third are the relevant alien tax rates of 30 percent for current income and 0 for capital gains. The alien tax rates are shown because foreigners have been a major participant in the U.S. government security market in the 1970's. The table shows that in the period following the 1969 Tax Reford Act the two alternative tax rate assumptions would have lowered the new issue equivalent yield series (prior to February 1973, when we switch to high coupon issue yields) by 10 to 20 basis points. Consequently, while the assumption is somewhat tenuous in later years, other reasonable assumptions have a fairly moderate, although not inconsequential, effect on the series.

TABLE I

NEW ISSUE EQUIVALENT YIELDS OF 4-1/4's OF 87-92
USING DIFFERENT TAX RATE ASSUMPTIONS

Observed Yield	Marginal and capital gains tax rates equal prevailing corporate rates	Marginal tax rate equals .40; capital gains tax rate equals .20	Marginal tax rate equal .30; capital gains tax rate equals 0
4.49 (1/66)	4.56	4.55	4.54
5.57 (1/68)	5.98	5.88	5.87
6.89 (1/70)	7.69	7.53	7.50
6.02 (1/72)	6.54	6.48	6.47

TABLE II

THE AVERAGE NEW ISSUE EQUIVALENT YIELDS FOR SEVERAL HIGH
COUPON U.S. BONDS (CORPORATE TAX RATES ASSUMED)

	1974	1975
6-3/4's of 93	8.28	8.20
7-1/2's of 88-93	8.13	8.12
7's of 93-98	8.16	8.21
8-1/2's of 94-99		8.26
7-7/8's of 95-00		8.32

On an ex post basis it is appropriate to ask whether the tax rate assumption results in equivalent after-tax yield series for different coupon bonds of similar maturity. Robichek and Niebuhr [19, p. 1089] looked at numerous pairs of low coupon bond issues of equal maturity in 1966 and 1969 and concluded that the tax rate assumption that best explained the spreads between their yields was a 44 percent marginal tax rate assumption (with a 22 percent capital gains tax rate assumption). This assumption would lower RUS* slightly prior to 1970 and leave it virtually unchanged thereafter, because the 44/22 assumption results in the same new issue equivalent yield series as the 48/30 corporate tax rates in force after the Tax Reform Act.

A better basis for judging the tax rate assumptions is to compare the new issue equivalent yield series of high and low coupon bonds of equal maturity. Unfortunately, due to the growing impact of the estate tax effect on the low coupon bonds in late 1973 there is only a short period in which to make this comparison. On average, from February through July 1973 the new issue equivalent yield of the 4-1/4's of 87-92 was 16 basis points higher than the new issue equivalent yield of the 6-3/4's of 93 providing some indication that the corporate tax rate assumption might be too high. Another worthwhile period of comparison is 1975, when there is a wide range of high coupon (6-3/4 to 8-1/2 percent) bonds. Table II shows the average new issue equivalent yields for five bonds. The table indicates that the corporate tax rate assumptions are roughly appropriate. For instance, the new issue equivalent yields of the 7's of 93-98 and the 8-1/2's of 94-99 are within five basis points of each other.

V. Risk Factors Affecting the Corporate-U.S. Yield Spread

We employ Salomon Brothers' Aa deferred-call utility yield series, RAa, as the corporate rate in our analysis because we believe it is superior to alternative available corporate yield series.[12] The major technical factors affecting RAa relative to RUS* are call risk and default risk. Default risk has influenced the spread between RAa and RUS* in three possible ways, each of which is treated separately below and in the spread regressions in the following section. First, there was an extraordinary rise in the impact of risk premiums on utility yield series following Con Edison's failure to pay a dividend in the second quarter of 1974. The spread between Salomon Brothers' Aa utility and Aa industrial yield series, which was stable through the 1970 recession, rose sharply in the second quarter of 1974 and remained unusually high through 1975. In this period the spread between the Aa utility yield series and RUS* can be divided into two parts:

$$(RAa-RUS^*) \quad = \quad (RAa-IAa) \quad + \quad (IAa-RUS^*),$$

where IAa is the yield on Aa-rated industrial bonds. These two parts correspond to the normal risk premium for Aa-rated securities observed over the business cycle and the special risk premium associated with Con Edison dividend failure. In the empirical work in the following section, rather than attempting to "explain" the special utility-related risk, the spread between RAa and RUS* is simply reduced by the amount due to the rise in the spread between RAa and IAa.[13] The resultant spread RAa* - RUS*, is the truncated

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[12]The Federal Reserve's new issue Aaa yield series is not used for reasons discussed earlier. Moody's new issue Aaa series is not used because it is a conglomerate rate for both industrials and utilities and consequently is affected by the relative mix of new issues; this is a particularly severe problem in 1974-75 when spreads between Aaa utility and Aaa industrial yields are often as high as 60 to 70 basis points.

[13]Specifically, beginning in the second quarter of 1974 we subtract (RAa - IAa - .22) from the spread. The 22 basis points not subtracted out

dashed series in Chart 1. As seen in the chart, this episode initially generated over a 40 basis point risk premium.

Two rationales for cyclical movements in default risk premiums have been advanced. Jaffee [13, p. 312] has argued that cyclical movements in risk premiums "are a technical feature resulting from the fact that Moody's does not adjust its ratings for short-run business cycle developments." An alternative, or at least contributing, explanation is that investors' views of risk vary systematically from Moody's over the business cycle. Kichline, Laub and Stevens [15, p. 12] provide an explanation along these lines citing Hirshleifer's time and state preference approach, which

> implies that the utility of a particular investment depends not only on the probability distribution of its monetary returns, but also on the 'state of the world' at the time those returns are received. A 'depression mentality' about securities markets may reflect both pessimism about future monetary returns, and a time in which investors don't think a given probability distribution on future monetary returns offers much utility--because of pessimistic beliefs about the future 'states of the world.'

Either explanation suggests a need to adjust the corporate rate to remove the impact of default risk or to incorporate variables reflecting cyclical default risk in a model explaining the spread between risky and non-risky bond yields.

Two proxies are used in the following section to attempt to capture the cyclical risk premium affecting the spread between Salomon Brothers' Aa utility yield series and the new issue equivalent U.S. bond yield series. The first is MOOD, a measure of consumer sentiment constructed by Fair [8] based on data collected by the University of Michigan Survey Research Center.

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represent the average spread between RAa and IAa prior to the Con Edison dividend failure. The Aa industrial yield series is not used over the whole period because it is not available prior to 1971.

Jaffee [13] found MOOD to be the most significant variable in almost all his risk premium regressions. The second proxy is the employment pressure index (EPI), a series developed by William Cullison [6] that measures labor market pressures by dividing actual employment figures by a population adjusted trend value.[14] The index is designed to measure excess demand or supply by assuming actual employment as a proxy for labor demand and using the trend as a measure of long-term labor supply.

The presence of default risk affects the specification of the yield spread regressions in a third way. It is not immediately clear whether the appropriate dependent variable when evaluating risk premiums is the ratio of yields or the spread between yields. Both measures have been used in other studies. The appropriate measure is the one that stays constant, when risk is constant, as yield levels change. Unfortunately, neither specification satisfies that requirement. Consider the following example. The after-tax yield r of a new issue \$100 risk-free bond sold at par is $C_1(1-t)/100$, where t is the appropriate tax rate and C_1 is the coupon. If a risk factor e is applied to both the coupon and the redemption value of a risky bond, then the expected after-tax yield r' of the bond is determined by the formula:

$$100 = \sum_{n=1}^{N} \frac{C_2(1-e)(1-t)}{(1+r')^n} + \frac{100(1-e)}{(1+r')^N} .$$

The promised after-tax yield of the risky bond is $r'' = C_2(1-t)/100$. Assuming e is fixed and the expected after-tax yield of the risky bond r' is kept equal to the after-tax yield of the riskless bond r, what will be the behavior of

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[14]Other risk proxies such as the observed unemployment rate and the Federal Reserve Board's capacity utilization rate for major materials were also tested.

(r"-r) and r"/r as yields rise (or fall)? The spread (r"-r) will rise as yields rise, but the ratio r"/r will fall. However, the rise in the spread as yields rise is linearly related to the rise in yields. Consequently, an appropriate procedure when estimating risk premium regressions is to use the spread as the dependent variable and the level of rates as an independent variable to capture the effect on the spread of a constant level of risk as yields rise. For low levels of risk--for instance e = .02--this effect is very small, hardly more than a basis point for each percentage point rise in yields. For high levels of risk, however--such as e = .08--the effect can be substantial, about 6 basis points for each percentage point rise in yields. Jaffee [13], without explanation, uses the level of rates as an independent variable in his risk-spread regressions and estimates significant coefficients ranging from 3 basis points to 5 basis points in equations explaining BAA-AAA corporate, industrial and utility yield spreads. Because the difference in default risk between Aa utilities and Treasury securities is less than that between BAA and AAA corporate securities, the impact of a percentage point increase in the risk-free rate should be even less than three basis points.

The second risk factor affecting the corporate bond yield series relative to RUS* is call risk. Jen and Wert [14], Frankena [10], and Pye [18] provide ample evidence that differential periods of call protection contribute to observed yield spreads. Salomon Brothers' Aa utility yield series is for bonds having 5 years of call protection, while the new issue equivalent U.S. bond yield series is for bonds that have 20 or more years of call protection. If rates are expected to fall to a level at the end of 5 years (or more) that will justify calling the utility bond, then the current utility bond yield will have to be high enough to compensate investors for the lower yield they expect to earn in the years following the call. Consequently, the spread between current utility and U.S. bond rates will increase.

An appropriate proxy to capture the impact of call risk on the corporate bond yield is the spread between two yields whose relative levels are solely a function of interest rate expectations. Finding two such yield series is difficult for the very reasons that have been discussed so far in this paper. For instance, Salomon Brothers has five and ten year U.S. rates that could be used to derive an explicit measure of the expected change in interest rates over a five year period. The ten year yield series, however, is unquestionably affected by the tax factors discussed earlier; hence the spread between the ten and five year rates would be a biased proxy for expectations. Similarly, there are yield series for long- and intermediate-term corporate (or municipal) bonds of the same rating category. The spread between the long and intermediate rates, however, is affected not only by interest-rate expectations but also by the relatively greater impact of call risk on the long-term rate.

To overcome these difficulties we chose as the interest-rate expectations proxy (EXP) the spread between Salomon Brothers 7 and 4 year U.S. rates. Unlike the ten year maturity bonds, there were new seven year notes issued during the second half of the 1960's. Consequently, the Salomon Brothers' seven year series is not significantly affected by tax factors. Furthermore, the spread between the seven and four year rates is clearly not affected by default or call risk. The Salomon Brothers' seven year series starts at the beginning of 1967. From 1961 through 1966 we use the spread between Salomon Brothers' five and two year U.S. yield series.

Our final proxy is to reflect the impact of relative security supplies (RSS). We define this proxy as the difference between the book value of corporate bonds, net of the rest of the world, and the level of long-term Treasury debt, net of holdings of the U.S. government and the Federal Reserve.

The former is from the Flow of Funds Accounts and the latter is from the Treasury Bulletin. We include all Treasury debt having a maturity of five years or greater.[15] This proxy was tested both in level form--changes in RSS have a permanent effect on yields a la Fair and Malkiel [9]--and in first difference form--changes have a temporary impact a la Hendershott and Kidwell [12]. An increase in RSS or ΔRSS should raise the rate spread.

Taking all the factors affecting Aa utility and Treasury long-term yield series into account, we estimate the following equation for the spread between the adjusted utility and new issue equivalent U.S. yield series:

$$RAa^*-RUS^*=f(\overset{-}{MOOD}, \overset{-}{EPI}, \overset{-}{EXP}, \overset{+}{RUS^*}, \overset{+}{RSS} \text{ and/or } \overset{+}{\Delta RSS}),$$

where the signs over the variables denote the expected sign of the estimated coefficients. The relationship between the dependent and independent variables is assumed to be linear.[16]

VI. Empirical Results

The results of the above yield spread regression estimated from the beginning of 1961 through the end of 1975 are reported in the Table. The yields are percentage points, EPI is the Employment Pressure Index ranging from 98 to 102 over the estimation period, MOOD is the consumer sentiment

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[15] A relative-security-supplies variable was also constructed using only net U.S. debt having a maturity of 10 years or greater. The variable is so closely correlated to the one specified above, however, that it makes virtually no difference which is included in the regressions.

[16] Actually, the relationship between EXP and the spread should not be linear since EXP, no matter how high, should never have a negative influence on the spread. That is, at very high levels of EXP, its impact on the spread should converge to 0. A functional form which has this characteristic is e^{-EXP}. Some of the equations reported in Section V were rerun using this form for EXP. The results, however, were extremely close to those reported assuming a strictly linear relationship between EXP and the yield spread.

index ranging from 58 to 97, and RSS is largely a trend that rises from \$65 billion to \$284 billion. The equations were estimated using generalized least squares and assuming a first order autoregressive error. The procedure is similar to the Corchrane-Orcutt procedure. The values of ρ are reported in Table III.

The first equation reported in Table III includes all the variables but RSS. The coefficients of the cyclical default risk variables, MOOD and EPI, and the call risk variable, EXP, both have the expected signs and are significant at the 5 percent level. The coefficient of RUS* has the expected sign and magnitude but is not significant. Equation (2) includes the RSS variable. The coefficient of RSS has a positive sign and is significant at the 20 percent level. Inclusion of the variable, however, has the effect of sharply lowering the coefficient of RUS*. This occurs because the two variables are highly correlated. (The correlation coefficient is .93 over the 15 year period.) Equation (3) is equation (2) with the coefficient of RUS* constrained to be .0205, its value in equation (1). The coefficient of RSS in equation (3) would imply that RSS caused 7 basis points of the rise in the (RAa*-RUS) spread between the beginning of 1962 and the end of 1969 or only 4 percent of the total rise. The change in RSS was substituted for RSS in equations (2) and (3) but did not have the correct sign in either equation.

Additional insight into the difficulties of accurately determining the impact of RSS on the yield spread is provided by equation (4), which repeats equation (3) with the dependent variable changed from RAa*-RUS* to RAa*-RUS (the <u>unadjusted</u> U.S. rate). The coefficient of RSS in equation (4) has a magnitude eight times greater than that in equation (3). Furthermore, it has a highly significant t-statistic of 2.85 compared to the t-statistic

TABLE III

SPREAD REGRESSION RESULTS: SALOMON BROTHERS' Aa UTILITY YIELD SERIES

LESS THE NEW ISSUE EQUIVALENT U. S. BOND YIELD SERIES

	Dependent Variable	Constant	MOOD	EPI	EXP	RUS*	RSS	SE	$\bar{R}^2$	ρ	D.W.
(1)	RAa*-RUS*	11.36 (2.23)	-.0116 (2.40)	-.0977 (1.97)	-.6698 (3.32)	.0205 (.42)		.23	.46	.74	2.02
(2)	RAa*-RUS*	10.88 (2.08)	-.0109 (2.22)	-.0914 (1.80)	-.7318 (3.54)	-.0551 (.66)	.0020 (1.02)	.23	.42	.76	2.06
(3)	RAa*-RUS*	10.31 (2.02)	-.0100 (2.06)	-.0894 (1.81)	-.6492 (3.40)	.0205	.0007 (.65)	.22	.41	.72	1.99
(4)	RAa*-RUS	13.76 (2.05)	-.0091 (1.51)	-.1250 (1.92)	-.8334 (3.66)	.0205	.0056 (2.85)	.36	.73	.86	2.33

Note: t-statistics are shown in parentheses. The SE and $\bar{R}^2$ (adjusted for degrees of freedom) are for the untransformed observations. The estimation period covers 60 quarters from 1961 I through 1975 IV. The Aa utility rate is adjusted in 1974-75 as described in the text. The coefficient of RUS* in equations (3) and (4) is constrained to .0205.

of .65 for the RSS coefficient in equation (3). These results occur because the impact of the tax effects on RUS as yields rise are captured by the RSS variable. (The correlation coefficient between RSS and RUS*-RUS is .92.) Equation (4) suggests that changes in RSS accounted for 61 basis points of the rise in the spread between the utility and average U.S. bond rate between the beginning of 1962 and the end of 1969, in contrast to the 7 basis points implied by equation (3). Failure to account for the tax effects on yields was apparently the reason Fair and Malkiel [9] obtained results suggesting the greater importance of relative security supplies.

The coefficient of the call risk proxy in equation (3) implies that the value of 15 additional years of call protection--that is, the value of 20 years call protection minus the value of 5 years call protection--rose 49 basis points from its lowest level in the first half of 1963 to its highest level in the second half of 1969. This value appears to be fairly close (although somewhat smaller) to the value of 15 years of additional call protection that would be forecast by Pye's model [18, p. 630] given the pattern of yield movement in the years prior to 1969.[17] The coefficients of the two default risk variables (MOOD and EPI), in conjunction with the movement in these variables, suggest that the 1969-70 and 1973-75 recessions raised the risk premium in the Aa bond rate by about 30 and 40 basis points, respectively.[18]

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[17]This conclusion is made on the basis of Tables II and III [18, p. 630] and a one year Treasury bill rate in 1969 of 6.77 percent. The Tables can not be used in later years, after rates had remained high for longer periods of time.

[18]These estimates seemed to us to possibly overstate the impact of cyclical default risk, especially in the 1969-70 period. On the other hand, the spread between Salomon Brothers' Aa and Aaa industrial yield series rose from 10 basis points in 1973 to 30 basis points in the first quarter of 1975. This increase does not appear inconsistent with our estimate of the rising impact of cyclical default risk on the spread between RAa* and RUS* over this period.

VII. Conclusion

We conclude that technical factors can reasonably explain the movement in the spread between Salomon Brothers' Aa deferred-call utility yield series and the Federal Reserve Board's long-term U.S. bond average yield series. The most important of these is the more favorable tax treatment extended seasoned discount bonds, which are heavily used to construct the average (and all other) U.S. yield series through most of the period studied. Another important tax-related feature affecting the yield spread is the provision allowing bonds issued prior to 1971 to be used for estate-tax purposes at par value.

Two other technical factors having a significant influence on the spread are call risk and default risk. The former occurs because corporate bonds underlying the Salomon Brothers' Aa utility yield series have only five years of call protection, while bonds used in the construction of the average (and other long-term) U.S. yield series have little or no call risk. The presence of default risk has influenced the spread in three ways: 1) through a cyclical risk premium, 2) through the impact of rising yields, given constant default risk, and 3) in 1974 and 1975 following the Con Edison dividend payment failure, which raised Aa utility rates initially by over 40 basis points.

Perhaps the most striking finding of the study is the lack of support for the view that relative security supplies are a significant factor contributing to the observed spread between the corporate and U.S. yield series studied. We do not find this surprising. For relative security supplies to affect an interest rate spread, there must be an absence of a large quantity of funds that are indifferent at the margin between the two securities. While we can imagine securities where this is true, high grade corporates and Treasury bonds are not likely candidates.

Lastly, the results of our analysis point out the extreme difficulties encountered when using a pair of yield series to isolate and analyze a particular phenomenon, such as the impact on interest rates of default risk, call risk, interest rate expectations or relative security supplies. As a result of these difficulties, great care should be exercised when making conclusions about any of these phenomenon on the basis of observed movements in yield spreads.

APPENDIX

The general procedure used to calculate the new issue equivalent U. S. bond yields is virtually identical to that employed by Robichek and Niebuhr [19], while the actual calculations follow a procedure suggested by Colin and Bayer [3]. We obtained monthly data from the Treasury Bulletin for each of the issues to be used in the calculation. Using the actual maturity of each bond over time, assuming semiannual coupons, and using the prevailing corporate income (t_c) and capital gains (t_g) tax rates, an after-tax yield series was calculated via the following formula:

$$P = \sum_{n=1}^{N} \frac{(1-t_c)\text{coup}}{(1+r)^n} + \frac{\text{PAR}}{(1+r)^N} - \frac{t_g(\text{PAR}-P)}{(1+r)^N}$$

It was then transformed into a comparable "new issue" before-tax yield series by dividing it by $(1-t_c)$. The actual issues and marginal income/capital gains tax rates used to compute the new issue equivalent yields were:

January 1961 - December 1963: 52/25

January 1964 - December 1964: 50/25

January 1965 - December 1969: 48/25

January 1970 - December 1970: 48/28.7

January 1971 - December 1975: 48/30

Table A1 lists the bonds whose yields are included in the long-term average U. S. yield series in or after 1961 and contains comments on how the various bonds relate to the "rules" specified in the paper. Two new issue equivalent U. S. yield series were constructed. The first, RUS*, used only the new issue yield series of the highest coupon bond issue outstanding at any point in time. These issues are shown in Table A2. The second series, RUS**, is an average of the new issue equivalent yields on those bond issues (shown in Table A3) passing the maturity rule and judged to be unaffected by the estate tax provision and that had coupons close to the highest coupon bond outstanding. For instance, whereas RUS* uses only the new issue equivalent yield of the 4 1/4's of 87-92 from May 1963 through February 1973, RUS** uses an average of the new issue equivalent yields of the 4 1/4's of 87-92, the 4's of 88-93, and the 4 1/8's of 89-94. There was little difference, however, between RUS* and RUS**, so RUS* was used in all the empirical work.

The monthly values of RUS* for the 1961-1975 period are listed in Table A4. After early 1973 the difference between RUS* and certain alternative U. S. bond yield series--such as Salomon Brothers and the Treasury Department's constant maturity series--lessens greatly because only the highest coupon bonds are used in the construction of these series, and in this latter period several high coupon non-flower bonds were issued. Nevertheless, through most of the 1973-75 period, RUS* is higher than these alternative series because even the high coupon bond issues were generally selling at discounts, sometimes quite large, in this period.

Table A1

BONDS INCLUDED IN LONG-TERM AVERAGE

U.S. YIELD SERIES IN OR AFTER 1961

Maturity (and call) date	Offering date	Comment
3 7/8's of 74	pre-1961	Maturity too short.
4's of 80	pre-1961	Maturity too short.
3 1/2's of 80	pre-1961	Maturity too short.
3 1/4's of 78-83	pre-1961	Coupon too low.
3 1/4's of 85	pre-1961	Coupon too low.
4 1/4's of 75-85	pre-1961	Premium bond through 1964; call period too short.
3 1/2's of 90	pre-1961	OK until 4 1/4's of 87-92.
4 1/4's of 87-92	August 1962	OK until 6 3/4's of 93.
4's of 88-93	February 1963	OK until 6 3/4's of 93.
4 1/8's of 89-94	May 1963	OK until 6 3/4's of 93.
3's of 95	pre-1961	Coupon too low.
3 1/2's of 98	pre-1961	OK until 4 1/4's of 87-92.
6 3/8's of 84	August 1972	Maturity too short.
6 1/8's of 86	November 1971	Maturity too short.
8 1/4's of 90	April 1975	Maturity too short.
6 3/4's of 93	January 1973	Maturity too short, but used until 7's of 93-98.
7 1/2's of 88-93	September 1973	Premium bond for first 6 months; maturity too short.
7's of 93-98	June 1973	OK.
8 1/2's of 94-99	June 1974	Usually a premium bond; call period too short.
7 7/8's of 95-00	February 1975	OK.
8 3/8's of 95-00	September 1975	OK, but disregarded because it has only 4 observations.
8 1/4's of 00-05	June 1975	OK.

Table A2

BOND ISSUES USED TO CONSTRUCT RUS*

From January 1961:	3 1/2's of 98
From August 1962:	4 1/4's of 87-92
From February 1973:	6 3/4's of 93
From June 1973:	7's of 93-98
From February 1975:	7 7/8's of 00-05

Table A3

BOND ISSUES USED TO CONSTRUCT RUS**

From January 1961:	3 1/2's of 98 3 1/2's of 90
From August 1962:	4 1/4's of 89-92
From February 1963:	4 1/4's of 87-92 4's of 88-93
From May 1963:	4 1/4's of 87-92 4's of 88-93 4 1/8's of 89-94
From February 1973:	6 3/4's of 93
From June 1973:	7's of 93-98
From February 1975:	7's of 93-98 7 7/8's of 95-00
From June 1975:	7's of 93-98 7 7/8's of 95-00 8 1/4's of 00-05

Table A4

NEW ISSUE EQUIVALENT U.S. BOND YIELD SERIES
(End-of-Month Rates)

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
January	4.15	4.33	3.96	4.18	4.23	4.67	4.58	5.75	6.85	7.79	6.77	6.71	6.88	7.54	7.90
February	3.94	4.33	3.94	4.18	4.25	4.94	4.81	5.83	6.85	7.23	6.96	6.62	6.94	7.62	7.87
March	3.96	4.19	3.98	4.25	4.23	4.73	4.65	6.06	6.87	7.38	6.50	6.77	6.92	8.06	8.35
April	3.85	4.08	4.03	4.22	4.23	4.81	4.96	5.88	6.52	7.88	6.83	6.75	6.94	8.37	8.56
May	3.87	4.17	4.03	4.14	4.23	4.88	5.02	5.87	7.10	8.42	6.92	6.54	7.12	8.25	8.29
June	4.10	4.27	4.04	4.14	4.23	4.96	5.37	5.73	6.92	7.98	7.12	6.67	7.19	8.29	8.19
July	4.12	4.17	4.02	4.20	4.23	5.02	5.33	5.50	6.88	7.73	7.13	6.52	7.79	8.54	8.38
August	4.25	4.06	4.02	4.22	4.29	5.23	5.44	5.54	7.04	7.85	6.71	6.52	7.40	8.85	8.56
September	4.27	4.02	4.08	4.21	4.35	5.00	5.50	5.69	7.65	7.69	6.54	6.65	7.04	8.75	8.75
October	4.25	3.96	4.15	4.18	4.37	4.83	5.92	5.85	7.33	7.81	6.40	6.44	7.35	8.27	8.21
November	4.28	3.96	4.15	4.22	4.46	4.98	6.15	6.17	7.62	7.12	6.54	6.29	7.23	8,04	8.44
December	4.33	3.90	4.18	4.23	4.56	4.65	5.98	6.56	7.69	7.21	6.54	6.58	7.38	7.90	8.16

REFERENCES

1. J. Bisignano. "Inflation and the Efficiency of Capital Markets," Federal Reserve Bank of San Francisco Economic Review, (summer 1976).

2. M. Brenner. "Determinants of Yield Differentials," forthcoming in A. Sametz, The Financial Environment, 1976-1985, D.C. Heath & Co., (1977).

3. J. W. Colin and R. S. Bayer. "Calculation of Tax Effective Yields for Discount Instruments," Journal of Financial and Quantitative Analysis, (June 1970), pp. 265-73.

4. T. Q. Cook. "Changing Yield Spreads in the U.S. Government Bond Market," Federal Reserve Bank of Richmond Economic Review, (March/April 1977). pp. 3-8.

5. T. Q. Cook. "Some Factors Affecting Long-term Yield Spreads in Recent Years," Federal Reserve Bank of Richmond Monthly Review, (September 1973), pp. 2-14.

6. W. E. Cullison. "An Employment Pressure Index as an Alternative Measure of Labor Market Conditions," The Review of Economics and Statistics, (February 1975), pp. 115-21.

7. S. W. Dobson. "U.S. Government Securities Reflect No Increase in Uncertainty," Federal Reserve Bank of Dallas Business Review, (October 1976), pp. 6-11.

8. R. C. Fair. A Short-run Forecasting Model of the United States Economy, D. C. Heath & Co., Lexington, Massachusetts, (1971).

9. R. C. Fair and B. G. Malkiel, "The Determinants of Yield Differentials Between Debt Instruments of the Same Maturity," Journal of Money, Credit and Banking, (November 1971), pp. 733-49.

10. M. W. Frankena. "The Influence of Call Provisions and Coupon Rate on the Yields of Corporate Bonds," in Essays on Interest Rates, Volume II, National Bureau of Economic Research, New York, (1971).

11. J. C. Hambor and R. E. Weintraub. "The Term Structure: Another Look," Journal of Money, Credit and Banking, (November 1974), pp. 551-57.

12. P. H. Hendershott and D. S. Kidwell. "The Impact of Relative Security Supplies: A Test With Data From a Regional Tax-Exempt Bond Market," Journal of Money, Credit and Banking, (August 1978).

13. D. M. Jaffee. "Cyclical Variations in the Risk Structure of Interest Rates," Journal of Monetary Economics, Volume I, Number 2, pp. 309-25.

14. F. C. Jen and J. E. Wert. "The Effect of Call Risk on Corporate Bond Yields," Journal of Finance, (December 1967), pp. 637-51.

15. J. L. Kichline, P. M. Laub, and G. V. G. Stevens, "Obtaining the Yield on a Standard Bond from a Sample of Bonds with Heterogeneous Characteristics," Staff Economic Studies '77, Board of Governors of the Federal Reserve System, (1973).

16. J. R. Ostas. "Effects of Usury Ceilings in the Mortgage Market," Journal of Finance, (June 1976), pp. 821-34.

17. J. E. Pesando. "The Interest Sensitivity of the Flow of Funds Through Life Insurance Companies: An Econometric Analysis," Journal of Finance, (September 1974), pp. 1105-21.

18. G. Pye. "The Value of Call Deferment on a Bond: Some Empirical Results," Journal of Finance, (December 1967), pp. 623-36.

19. A. A. Robichek and W. D. Niebuhr. "Tax-Induced Bias in Reported Treasury Yields," Journal of Finance, (December 1970), pp. 1081-90.

20. Salomon Brothers, An Analytical Record of Yields and Yield Spreads, New York, (1976).

21. W. T. Terrell and W. J. Frazer, Jr. "Interest Rates, Portfolio Behavior, and Marketable Government Securities," Journal of Finance, (March 1972), pp. 1-33.