

Some New Bond Indexes*

by

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Working Paper No. 7-73a

*This is an abridged combination of Working Paper #7-73, "Some New Bond Indexes," and Working Paper #2-74, "Some New Bond Indexes--Extended and Expanded Results."

I. Introduction

This paper presents several continuous investment performance indexes based on time series of returns for United States government securities for the period January, 1947 through May, 1973. Each index contains only those government securities with a specified term to maturity and provides a performance standard for comparison with other government and non-government securities. The goal, in terms of index selection, is to present indexes representing as many different maturities as possible based on market data and to compare the returns upon which the investment performance indexes are based in both the before and after tax situations.¹ In addition, there is a comparison of returns to an investor, over selected long periods, for two alternative investment policies. It turns out that many of the time series of returns are closely correlated and that the degree of differentiation used here may be more than necessary for most analyses of the bond market. Moreover, it appears that a 'buy and hold' investment policy is superior to the alternative policy.

After describing the sample, the grouping techniques that are used in this paper are discussed. We will also present the indexes and some summary statistics. Finally, we will compare investment policies and will describe some possible implications of the returns and indexes.

* Assistant Professor, University of Pennsylvania. Early drafts of this paper benefited greatly from my discussions with Merton Miller. I also received helpful comments from Irwin Friend, Hans Stoll and Randolph Westfield. Bert Tyler did some computer work for the project. However, I retain responsibility for the opinions and any mistakes. This paper was partially financed by NSF grant IG-72-44 and a grant from the Rodney L. White Center for Financial Research.

1. See J.B. Michaelson, "The Term Structure of Interest Rates and Holding Period Yields in Government Securities," *Journal of Finance*, XX:3 (September 1965). His study issues a weekly holding period. In addition, his study has placed increased emphasis on short term Treasury bills at the expense of other government securities. The general results in his study are similar to those observed here.

II. The Sample

The results presented here are based on month-end price data and on interest accrual and payments for the sample period. Included in the sample of government securities is the universe of publically traded U.S. government bonds and notes and those Treasury bills which, at one end of any given month, are approximately a full number of months from maturity.²

There are several advantages to the use of this sample of government securities. First, there is substantial homogeneity in that all the securities represent only one issuer. Second, since the sample contains only direct obligations of the U.S. government, the default risk present in the pricing and returns associated with the securities at any time is as low as on any security in the world. Third, the securities are highly marketable. The large size of each issue and the large number of investors associated with each issue ensure relatively narrow bid-ask spreads and many trades. In this case, the security's current price is likely to be an up to date, unbiased estimate of the security's true value.

However, the raw data have some relatively minor problems. In particular, prices were obtained for each bond included in the sample and, in many cases, were compared against prices from an alternative source. Since, in some cases, the price for a specific security depends on the source that is used, it appears that the prices are truly

² The sample includes only those securities which are traded publically during the period. For example, although the U.S. government issued a 2-3/4% non-marketable bond which is convertible into marketable 1-1/2% notes, only the notes are included in the indexes.

estimates of the security's true value.^{3,4} Moreover, Treasury bill yields are listed to two decimal places. This is only an estimate of the true yield as indicated by the extended calculation of the yield associated with each new offering of a Treasury bill.⁵

³ The data for the study were obtained from month-end Salomon Brothers quote sheets. Much of the data was checked against quotes available in the Wall Street Journal. Although not every observation was compared with the corresponding quote in the Wall Street Journal, the check included several complete comparisons of data available from this source on given dates to the data available on the Salomon Brothers quote sheets. The dates chosen for such comparisons ranged from random months to several years of successive observations. It should be noted that the quote sheets and the newspaper depend on different sources of information. As a result, the prices sometimes showed small fractional differences. In these cases, the Salomon Brothers data were retained for the sake of continuity.

The data were also passed through filters examining price levels, price changes, rates of returns and spreads between the bid and ask prices. For example, all bond price changes in excess of two points and all gains or losses in excess of two percent were checked. The most useful filter appeared to be the check on spreads. Any spread that was an odd number of 32nds was checked as was any spread in excess of one point and any change in spreads (e.g., from 8/32nds to 4/32nds). Moreover, any irregularity in the pattern of spreads across bonds and bills at any given time was checked. In the case of bills, any irregularity in the yield curve was checked. Obvious errors (e.g. where the bid price was more than the ask price) were connected via taking the alternative source. If there were sizable discrepancies between the sources that could not be traced immediately to an obvious typographical error, then alternative sources such as the Commercial and Finance Chronical or the Bank and Quotation Record were examined and the price stated by two of three sources was accepted. If three widely differing quotes were found with no obvious errors, then the average of the three quotes was taken and rounded to the nearest 32nd. The latter event occurred in very few cases. Resultingly, any remaining errors are small in magnitude.

Finally, the features associated with each security were checked in that each bond's features were obtained from at least two Moody's Manuals.

⁴ The relatively close agreement on prices can be considered a positive aspect of the data. General agreement on prices from two different sources narrows greatly any posterior distribution about a given price and confirms the quality of the data. It is likely that a comparison of the prices of a given security on multiple stock exchanges and in the over the counter market would yield larger differences in the prices than are observed in this data.

⁵ For this study, the banker's discount yields listed in the sources have been converted into price data.

No attention is paid to special features of specific government securities except for size of issue, coupon, the presence of a call feature, the presence of an estate tax feature and the security's term to maturity. However, the Government has issued securities with many differing provisions. During the 1947-1973 period, outstanding government securities presented investors with an opportunity to obtain a variety of tax treatments on interest income. In addition, some securities had, by law, limited markets at some times. Each of these features is priced in the market place, and may affect the returns and risks perceived to be associated with the securities. Each of these provisions was associated with only a small number of bonds and/or was in the market for relatively short parts of the sample period. It is assumed that these features do not have a material effect on the study.

If a bond has a call feature and was called by the U.S. government, then it is included in the indexes according to its term to call date. If the bond is not called, it is included in the indexes according to its term to maturity. While this solution to the call feature problem may appear arbitrary, it may represent investors' expectations with respect to these securities because, in practice, the U.S. government called every callable bond during the sample period until 1962. Since this time it has not exercised its call option on any bond. Accordingly, depending on whether a bond had a call option before or after 1962 investors could be reasonably certain that a callable U.S. government bond would or would not be called.⁶ A test of the effect of this assumption is included in the empirical section. Moreover, tests of the effects of the estate tax feature and the usefulness of knowing issue sizes will be discussed later.

⁶ Any number of assumptions can be made. None is satisfactory to everyone.

The different coupons associated with the various U.S. government securities means that different portions of each security's returns are subject to income taxes. The effects of differential taxes on income versus capital gains and the resulting differential net taxes on each security's returns necessitates after tax holding period returns. Unfortunately, since most investors face unique and individual tax situations, there is no single approach that adequately represents all investors. Two different representative tax treatments are chosen. The first treatment uses marginal corporate tax rates for a given period to adjust the before tax coupon and capital change returns for that period. In the second case, the chosen tax rates are those facing an investor whose personal taxable income is in the 90th percentile of all incomes at all times during the period under consideration.⁷ In each case, all capital losses are assumed to offset other capital gains. Moreover, in every case, except for the 1½% notes issued each April and October, it is assumed that the security is issued at par.⁸

The major results presented in this paper are based on pre-tax information. However, any differences between before and after tax results will be discussed.

III. Developing the Time Series of Returns

In the following section there is a detailed discussion of the development of each time series of returns.

⁷ The 90th percentile rate has been estimated for the months which are more recent than those periods covered by annual published analyses of personal tax patterns in the U.S.

⁸ If each 1½% security were assumed to be issued at par, then the before tax yield on these securities would have been less than the market yield at the time of issue. Instead, it is assumed, for tax purposes, that each 1½% bond was issued at the first available month-end price. The issue price ranged generally from 85 to 95.

A. Calculation of the Holding Period Returns

The holding period return for a given U.S. government security in period t, R_t , in percent per period form, is calculated by

$$R_t = \frac{(P_t + \frac{n}{m} C) - (P_{t-1} + \frac{n-1}{m} C)}{P_{t-1} + \frac{n-1}{m} C} \times 100$$

$$= \frac{P_t - P_{t-1} + \frac{1}{m} C}{P_{t-1} + \frac{n-1}{m} C} \times 100$$

where P_t and P_{t-1} are the market prices of the security per \$100 of par value at the end of periods t and t-1 respectively and C is the periodic interest payment per \$100 of par value. In addition, m is the number of holding periods between interest payments and n is the number of holding periods accrued toward the next interest payment at the end of period t.⁹ Then $\frac{1}{m} C$ indicates "straight line" accrual of interest earned for holding the security during that period t where each period is assumed, for simplicity, to be equally long.^{10,11}

⁹ Appropriate adjustments are made to the formula for interest payments made during the period. Moreover, n is adjusted for securities maturing on the 15th of the month.

¹⁰ This formula works equally well for Treasury bills. Since C is zero, the equation reduces to

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

¹¹ Interest is accrued to Treasury securities using 'straight line' accrual and a 365 day year. In the case of a typical month, this simplification is unlikely to be of great importance. Use of 12 equal months for interest accrual creates an expected holding period of 30.417 days. This approximation often yields a difference of well under 1/100 of 1% from the interest accrual over the exact period. The major difficulties with this approximations appear to be for periods where the delivery date is affected by weekends or holidays and in February. However, even in the most extreme cases such as combining a holiday and a weekend and high interest rates the approximation is accurate within 5/100 of 1%. For comparison, if a bond is priced at par at the beginning of a period, and if two price quotes at the end of the month are 1/32 apart, then the returns implied by the prices are over 3/100 of 1% apart. Also, note that, over time, the cumulative error in returns will be relatively small as overestimated returns due to overstated interest accrual will be balanced by underestimated returns due to understated interest accrual.

The interest accrual is shown explicitly because the purchase of a U.S. government bond contains two parts. The first part is payment of the quoted price ex-interest (the mean of the bid and ask prices) and the second part is payment for any interest that has already accrued toward the next interest payment. Accordingly, the holding period return obtained by purchase of the bond at the beginning of the holding period and sale of the bond at the end of the holding period recognizes the bondholder's claim to the new market value of the bond and his claim to the interest accrued and realized during the holding period.

B. Terms to Maturity and the Construction of the Time Series of Returns

It is well known that as the difference in the term to maturity between any two bonds increases, one issue becomes a progressively poorer substitute for the other. Moreover, a single bond displays changing performance characteristics as its term to maturity decreases. This necessitates the construction of several parallel time series of returns rather than a single time series in order to observe and compare the performance of U.S. government securities with different terms to maturity during a given time period. As single bonds approach maturity, they change periodically from one time series to the next. Moreover, there is a continuous turnover of bonds in any given time series and each time series maintains an approximately constant term to maturity.

In order to minimize the term to maturity problem as many time series as possible are generated for the sample period. The time series are listed in Table 1.¹² The title of each time series indicates the term to maturity remaining for securities in the index at the end of the period. The 0 month index contains securities that mature at the end of the period.

¹² If a security falls on a boundary between two time series, then it is included in the series with the shorter term to maturity.

Many of the time series represent ranges of terms to maturity rather than a single term to maturity. In these cases any security within the chosen range is grouped into the appropriate time series along with all other securities within that given range. If a time series represents a range of terms to maturity, then the actual term to maturity represented by the time series will vary from month to month as bonds age, enter and leave the time series. However, as the list of time series indicates, the range within which the actual term to maturity for any time series varies is small relative to the term to maturity of the time series. Resultingly, it is unlikely that the use of ranges of terms to maturity for the longer term time series has a material effect on the usefulness of the indexes.¹³ Finally, one possible composite U.S. government bond time series is included. This composite time series weights equally each time series representing a given term to maturity.¹⁴

The desired goal of generating as many parallel indexes and time series of returns as possible using only data from real U.S. government bonds results in some series that are occasionally represented by a small number (sometimes only one) U.S. government securities in any given period.¹⁵ In fact, as

¹³ The time series for the long term bonds have wider ranges of possible actual terms to maturity. However, a given time period is probably less likely to change the performance characteristics of a security with a long term to maturity than of a security with a short term to maturity. For example, one month is 50% of the remaining life for a security that matures in two months, but one month is less than 1/2% of the remaining life for a security that matures in 20 years.

¹⁴ No special qualities are claimed for this specific composite time series.

¹⁵ It is in these cases where one may intuitively feel that the quality of a given return is most suspect. One can imagine that some very specific event might affect that security during the period. In this case the return for the security (and the series) for the period might not be representative of what would normally have occurred. If there are more bonds in a given series, then this problem would be mitigated. Since each security is issued by the same issuer, this problem may not be as severe as it normally would be.

indicated in Table 2, there are no securities available to represent particular terms to maturity during some periods. In order to preserve the continuity of the time series, returns for these time series during these periods are estimated using a procedure¹⁶ discussed by Afifi and Elashoff.

This is the only situation where entirely simulated returns are included in the study. One can argue in favor of including these simulated returns as there are relatively few returns must be simulated to complete any given index. Moreover, these observations make it possible to expand our set of continuous indexes and time series greatly and to make extended use of the available data.¹⁷

C. Weights of Securities in the Time Series and Indexes

Every security in a given time series has the same importance as every other security in that time series for that given period.¹⁸ This approach is chosen for ease after a preliminary study tentatively suggested that the

¹⁶ See A.A. Afifi and R.M. Elashoff, "Missing Observations in Multivariate Statistics III: Large Sample Analysis of Simple Linear Regression," Journal of the American Statistical Association, LXIV (March 1969). In short, whenever fewer than 30% of the observations are missing from a single regression relationship, Afifi and Elashoff show that the Missing observations can be filled in adequately by generating a regression relation between the two variables based solely on the complete observations. Any missing observation for the dependent variable can be filled in by using the known observation for the independent variable and the regression relation. In this particular problem we have no obvious way to choose the appropriate independent variable for the above purpose. Instead, when there is a missing observation the closest adjacent series with a shorter term to maturity and the closest adjacent series with a longer term to maturity are used as independent variables to generate regression estimates of the missing observation. The average of these estimates is used as the best estimate of the missing observation. In every case the series with the missing observation was closely correlated with the chosen independent series when only complete observations are considered. In the case of the extreme indexes, the closest adjacent series was given an 80% weight arbitrarily and the next closest series was given a 20% weight to develop a simulated observation.

¹⁷ If there were no simulated returns, then several of the series would have had to be combined because of only one or two missing observations.

¹⁸ Since each series is given equal weight in the composite series, the individual securities do not have equal weight in the composite series.

series based on this weighting scheme were insignificantly different from series using the initial issue size of each security for weighting purposes.¹⁹

D. Special Techniques Used for the Series Representing the Performance of Securities with Short Terms to Maturity.

Standardization of the term to maturity associated with a time series is particularly important for the time series representing the performance of securities with short terms to maturity. Accordingly, the raw data is adjusted in order to arrive at more representative series for securities with short terms to maturity. In particular, in addition to the appropriate bonds and notes, only those bills which are either full months from maturity or are closest to some full number of months from maturity at the end of any given holding period are included in the indexes representing single terms to maturity. In order to obtain an observation for a series representing a single term to maturity when there are no bills maturing in some full number of months, an average of the returns on selected substitute bills is used. In particular, the return on the bill with the term to maturity closest to, but less than the appropriate full number of months to maturity is averaged with that on the bill with the term to maturity closest to, but more than the appropriate full number of months to maturity.²⁰ In addition, the time period associated with the 0 month time series is standardized so as to indicate the return for a 30 day holding period ending with the maturity of the security.

¹⁹ The distributions of returns for series, based on the alternative weighting scheme, are not significantly different from those presented for comparable series in the paper. Moreover, the comparable series are highly correlated over time.

²⁰ The averaging technique allows the bill that is closer to a full month to maturity than the second one under consideration to receive more weight. For example, if one chosen bill matures two days before the end of the month and second chosen bill matures five days after the end of the month, then the first bill is given $\frac{5}{7}$ of the weight and the second bill is given $\frac{2}{7}$ of the weight in the resulting observation.

There are also adjustments for bonds that mature in the middle of the month. Since half a month represents a large portion of the remaining life of a security when it is only a few months from maturity, inclusion of these bonds in the time series with the shortest terms to maturity could distort these series. In order to prevent distortions of the holding period returns due to this problem these bonds are dropped from the series when they would normally enter the series representing securities two months from maturity.

E. Characteristics of the Time Series and Indexes

With the exceptions mentioned earlier, all marketable Treasury securities are included in the study regardless of their features for completeness. This policy will be examined wherever it is appropriate.

The time series of returns and the investment performance indexes of securities with less than a year to maturity are dominated by Treasury bills. The series representing the performance of securities with one to five years to maturity are dominated by notes. The longer term series contain Treasury bonds. As the notes and bonds age, they pass through the series dominated by the bills and by the notes and bills respectively.

Note that some useful and necessary approximations have been made to develop these indexes. Due to these approximations, including those in the data, the returns in any given period are best characterized as estimates of the true returns to securities in that period. Moreover, the actual series are averages over these estimated returns.

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²¹ The observations save space in this form and yet, include many significant places for aid in combining in order to consider performances over several periods. Moreover, all calculations have been done with double precision accuracy in order to minimize error due to computer approximation techniques. Despite this precaution there is no reason to believe that the results are exact to the last place. If R_{it} is the return, in percent per period form, then $1+R_{it}/100$ is the corresponding investment relative.

In addition to these characteristics, the after tax returns to the series with terms to maturity in excess of one year are on an accrual basis rather than a realized basis as it is assumed that the investor's horizon is over 6 months and that any capital changes are taxed at the capital gains rate. The time series for maturities with less than one year to maturity are heavily weighted with Treasury bills. Since all returns to Treasury bills are taxed as income, the after tax returns in these cases can be considered as an accrual or realized return. If all the returns to all securities were considered on a realized basis and if each month were considered as a separate holding period, then all returns would be taxable as income. In this case, the pre-tax results could be adjusted by $(1 - t)$ where t is the effective income tax rate for the period to obtain an after tax return.

IV. Some Characteristics of the Returns

In this section we present some summary information about the pre and post tax time series of returns based on every (original and simulated) observation. In every case the returns have been examined in their raw form and after adjustment via subtraction of the 0 month rate.

Although the full range of time series was examined and will be discussed here, space limitations necessitate restricting the statistics presented here to those based on four representative time series. Because the time series of returns for adjacent maturities turn out to be very similar to each other the statistics presented here are representative of those obtained from the full range of time series of returns. Additional statistics are reported where they can shed substantial additional light on the interrelations among the returns. Selected investment performance indexes based on the time series of returns are in Table 3

where December, 1960 is set equal to 100.²² The time series of returns for these indexes are in the appendix.

The means and standard deviations of the indexes in return form and after subtraction of the 0 month return form are presented in Table 4. As the term to maturity of the time series of returns increases, the returns increase and then decrease. Moreover, it appears that the realized returns for the longer term time series are less than the returns to the 0 month series. Inclusion of the differential tax adjustments do not affect the basic pattern of interrelationships among the average holding period returns. If a return is greater before tax than a second return, any differential tax patterns are unlikely to be sufficiently strong to change this ordering in an after tax situation. The average returns also suggest that the realized return on long term securities, during the sample period is, even after taxes, less than that for the 0 month security. It should also be noted that, on a percentage basis, tax burdens fell more heavily on the long term securities during this period. This means falling prices for the long term securities include coupon accruals and capital losses. Since the capital losses decrease taxes at a lower rate than coupon income increases taxes, the net result is a higher effective tax rate.

The standard deviation of the monthly return for each time series increases as the term to maturity of the time series increases. In addition, the table also shows that the standard deviation of most of the time series is less when the series is presented in adjusted form than when it is presented in return form. This difference in standard deviations appears because the returns in the 0 month time series change over time. When the time series

²² The investment performance indexes are generated from equations (12) and (12') in L. Fisher, "Some New Stock Market Indexes," Journal of Business, XXXIX (January, 1966). December, 1960 is as chosen as the base month to ease any comparison of these indexes with those in that article. The investment strategy represented by these indexes is but one of many that could be followed.

are presented in adjusted form the variance in each index related to changes in the 0 month returns is eliminated. The decrease in the standard deviation of the time series appears largest for the short term indexes thereby suggesting that the level of the 0 month return may be a very important aspect of the return realized from short term securities in any given period.

There is no need to list the other summary statistics for each set of returns and standard deviation as the statistics, in both the before and after tax situations, are well represented by the results that will be presented in the pre tax case.

The vast majority of bonds in the longest term time series have the estate tax feature. In this case, the low average realized returns in a given period might be traded off by investors against the possibility of providing an immediate high return to the investor's estate in case of death.²³ In order to observe the effect of the estate tax feature on the relative returns associated with each time series, the returns were recalculated in cases where after exclusion of the bonds including the feature, non simulated data were still available. The results obtained from comparing time series after the estate tax bonds have been removed are the same as that which was obtained when they were included in that the average returns and standard deviations of the returns have the same ranking for the (non continuous set) of time series observations remaining after removal of the bonds as for the same set of observations before removal of these bonds.²⁴ This result appears to occur primarily because the bonds with the estate tax feature and with less than 20

²³ It might be more accurate to measure the returns on these securities in an actuarial sense.

²⁴ As an example, it appears that, if long term returns are greater than short term returns over a period where estate tax bonds are removed, then if they are included, the holding period returns to the longest term bonds are still greater than those to short term bonds.

years to maturity often account for only a small portion of those securities in a given time series. Hence, they have little or no impact on the ordering of the results for the well over 200 months with a full set of observations for these time series after removal of the estate tax bonds. It is harder to judge the impact of the estate tax feature on returns to the over 20 year index and time series. Only 68 of 312 non simulated observations remained after removal of the estate tax bonds. Further examination of these observations indicates that many of the observations are from the first half of the sample. For this period it appears that the bonds with the estate tax feature had little or no impact on the ordering of returns on government securities. However, little can be said for the second half of the sample period for this time series.

The effect of the assumptions described above with respect to the call feature appear to have no significant impact on the time series. The series were reconstructed excluding those securities with call features. In this case, relatively few observations were lost.²⁵ The results obtained from tests of the reconstructed indexes are identical with those described here in that inclusion or exclusion of these securities in the fashion described above has little effect on the time series.²⁶ However, it is possible that other assumptions about the call feature could have a major effect on the time series.²⁷

²⁵ In the vast majority of cases, exclusion of a callable security merely meant that less data were included in a given time series observation.

²⁶ The washing out of the effect of the call feature is not necessarily good. It could be argued that the change in policy was unexpected and that there was a substantial change in expectations when policies were changed.

²⁷ For example, if all callable bonds were included in the time series based on their term to call date until 1962 and then were placed in time series based on their term to maturity there might have been substantial changes in value in 1962. However, if this assumption were accepted, then many more observations would have had to be simulated to complete the time series of returns.

Table 5 contains the correlations between the time series in return form. Note that the time series with similar terms to maturity appear to be highly correlated.²⁸ The correlation between adjacent time series is always at least .86 and is usually greater than .90. This table and Table 4 suggest that the market does not make major differentiations among holding period returns for securities that are alike in quality, but are marginally different in term to maturity. The small differences in performance among successive time series also supports the argument that the range of terms to maturity in any given series is small relative to the term to maturity represented by the series. In addition, this result suggests that the differentiation among securities with differing terms to maturity used here is sufficient for many purposes. However, if Table 6 is read in the order of decreasing term to maturity, then a steadily decreasing regression coefficient is obtained from regressing the returns in each series on the composite bond time series. This suggests that the investor recognizes decreasing sensitivity of returns to a bond as the bond ages relative to a typical bond as represented by the composite bond series.²⁹

Table 5 also indicates that the short term series have a relatively weak correlation with the long term series. One possible explanation is that the performance of these extreme series depend on different stimuli. In particular, a return to a bond includes both a coupon accrual and a capital

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These correlations include the simulated observations generated earlier. However, correlation excluding these observations are only marginally different.

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The composite bond index is not an adequate replacement for a more general market based on additional securities. There is some question as to the direction and strength of the relation between these bonds and a more general index. An examination using preliminary data and a common stock index suggests that the various time series have weak negative relationships with the common stock returns.

change. Although the amount of coupon accrual for a given bond is a function of the length of the time period under consideration, the capital change is a function of both the length of the period and the change in yield. If continuous interest is assumed, then the price, P , of a bond is $P = \frac{C}{r}(1 - e^{-rt}) + Fe^{-rt}$ where C is the coupon, F is the par value of the bond, r is the bond's yield to maturity and t is the bond's term to maturity. Any capital change is represented by

$$dP = \left(-\frac{C}{r^2} + \left(\frac{C}{r^2} + \frac{Ct}{r} - Ft \right) e^{-rt} \right) dr + (C - Fr) e^{-rt} dt. \quad 30$$

The limit of the capital change as t approaches infinity is $dP = -\frac{C}{r^2} dr$, identical to that for a perpetuity. The limit of the capital change as t approaches zero or as a bond approaches maturity is $dP = (C - Fr) dt$. It is clear that the returns to Treasury bills, which represent the bulk of the short term securities, are then primarily a function of the length of the time period and are interest rate types of variables. However, the return to longer term bonds are more likely to be functions of changes in the yield to maturity and changes in the term structure of interest rates. Since the length of the time period (dt) is held constant throughout the sample period, it is highly likely, in the case of Treasury bills, that successive returns, being primarily a function of time, are highly correlated. However, changes in yields to maturity do not follow any such pattern. Therefore, it is unlikely that successive returns to long term indexes are correlated. In addition, as a security ages, its capital changes are related less and less to changes in the yield to maturity and more and more on the passage of time. Resultingly, there should be an increasing autocorrelation between successive returns to a bond as it ages and as the composition of its returns change. The autocorrelation coefficients, in

³⁰ The continuous equivalent of the coupon payment is also part of the overall return to the investor.

Table 7, follow this pattern. However, after the adjustment for the 0 month rate, the autocorrelations decrease by varying amounts over the full range of indexes and show a different pattern.

V. Returns Over Long Holding Periods

Although the time series measure monthly returns, many investors have longer horizons. Moreover, many investment strategies can be followed. This section compares the returns from two alternative investment strategies over several selected time periods. The first strategy could be called a 'maturity maintenance' strategy as a typical security (series) with a maturity in excess of 1 year is bought at the beginning of the chosen time period and is sold at the end of six months. After the appropriate tax has been subtracted, a security with the original maturity is bought again and is again held for six months. This process is repeated for the full holding period and includes reinvestment of coupons. Any reinvestments of coupons are done after tax, at the appropriate market prices. The second strategy is the 'buy and hold' strategy wherein the investor buys a security, reinvests the coupons as they are paid, and replaces the security upon maturity with a new security with the identical term to maturity as the original security. Whenever a new security is purchased it is assumed to be purchased at par with a coupon equal to the yield to maturity at that time for securities with the chosen term to maturity. This assumption is for simplicity and effectively assumes that the Treasury is continuously issuing new securities of all maturities. Moreover, it should be noted that the presence of 14 indexes representing all maturities precludes an exacting comparison between marginally different investment policies with respect to original terms to maturity.

The securities with initial maturities under 1 year are handled as though they are Treasury bills with discount prices and no coupons. Note

that, in some cases, the initial maturity is less than six months. In these cases the maturity maintenance and buy and hold strategies are identical.

Since transactions costs are negotiable, they have not been included explicitly in the analysis. There is a purchase at the beginning of the period and a sale at the end of the period. During each year there are additional transactions, as indicated in Table 8, depending on the initial maturity of the security and the investment strategy.

Tables 9 through 12 contain the results, in terms of annual rates of return, for 8 selected holding periods. In addition to these holding periods, there are average before tax annual rates of return for 7 periods of rising interest rates, 5 periods of falling interest rates and 3 periods of level interest rates as based on movements of the riskless rate. The 8 holding periods represent the full sample period, the Pre-Accord period, the Treasury-Fed transition period, the Post-Accord period, the 'Bills Only' period, the 'Post Bills Only' period and 2 additional periods.³¹

The long term securities outperformed the short term securities only during the Pre-Accord period when the Federal Reserve System controlled interest rate levels.³² During the other continuous periods the long term

³¹ See L. Fisher and James H. Lorie, "Rates of Return on Investments in Common Stocks," Journal of Business XXXVII (January, 1964) for the returns to common stocks for several holding periods including two that coincide with those chosen here.

³² The Pre-Accord period was the only period where, after deletion of the estate tax bonds, the long term bonds outperformed the short term bonds. This result is consistent with those in the text for the full sample of bonds.

securities performed no better than the short terms securities and often were outperformed by the short term securities.³³ During the periods of level rates it appears that returns to long term bonds are higher than those to short term bonds. If interest rates are expected to be level, then the result is consistent with the feeling that positive risk premiums and higher rates of return are demanded by investors in order to compensate for the additional risk accepted by those investors. However, it should be noted that there are very few periods of level interest rates and that these periods are not long lasting. In periods of rising and falling interest rates, the long term securities underperform and outperform the short term securities respectively.

In the absence of taxes and any adjustment for transactions costs the superiority of one investment scheme over the other depends on the particular term to maturity and sample period under consideration. A comparison after adjustments for taxes yields the same results. However, since the different strategies often yield marginally different returns, the additional transactions associated with the maturity maintenance policy are likely to be greater than any marginal benefits obtained in terms of extra returns. Hence it is likely that the buy and hold policy, on average, is the superior investment strategy to the maturity maintenance strategy.

VI. Conclusion

It is hoped that these indexes and time series of realized returns will be useful in future studies. However, these indexes and series should

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The actual rates of return for the columns representing rising, falling and level rates are less important than the pattern of the rates of return in relation to each other as annual rates of returns were calculated for each period included in any one of these groups of returns. These annual rates were then averaged together with rates for other periods included in the same group thereby weighting each period equally despite their differing lengths. Moreover, since the groups are described only by the direction of interest rates, they include many different rate levels.

be used cautiously. There is the fundamental problem of determining whether or not these distributions of holding period returns truly represent expected returns to investors. If the distributions of realized returns in this study are closely related to distributions of expected returns for bonds, it appears that in some cases, there may be a negative risk premium for long term bonds.³⁴ On the other hand, if there is no risk premium or some positive risk premium associated with long term bond investments relative to short term bond investments, then it appears that the market may have regularly underestimated the future long term bond rates. This suggests that the market may not learn quickly and that realized returns may be very different from expected returns in the bond market.

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This has been proposed as an outgrowth of portfolio theory. A "preferred habitat" theory might also produce these results.

Table 1

Term to Maturity of Time Series for Selected Periods*
January, 1947 - May, 1973

0 Month	3-4 Years
1 Month	4-5 Years
2 Months	5-6 Years
3-6 Months	6-10 Years
6 Months - 1 Year	10-15 Years
1-2 Years	15-20 Years
2-3 Years	Over 20 Years

* The securities in any given series have remaining terms-to-maturity within the range stated for that series at the end of the period. The security representing the 0 month security matures at the end of the period.

Table 2

Missing Observations by Series*
317 Observations

Index	Number and Percent of Missing Observations Filled in by Simulated Observations	
3-6 Months	33	10.4%
1-2 Years	4	1.3
5-6 Years	20	6.3
10-15 Years	3	0.9
15-20 Years	3	0.9
Over 20 Years	5	1.6

*If a series is not listed in the table, then it has no missing observations.

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1947												
0 MONTH	80.04	80.06	80.08	80.11	80.13	80.15	80.18	80.20	80.23	80.28	80.33	80.38
1-2 YEARS	74.69	74.75	74.85	74.82	74.90	74.95	75.02	75.10	75.13	75.08	75.13	75.19
6-10 YEARS	75.59	75.74	75.96	75.85	75.86	75.93	76.30	76.62	76.56	76.10	75.34	73.70
OVER 20 YEARS	79.22	79.51	79.90	79.90	80.08	79.79	79.87	80.32	80.34	75.59	79.10	78.36
1948												
0 MONTH	80.44	80.50	80.56	80.63	80.69	80.76	80.82	80.89	80.96	81.03	81.10	81.17
1-2 YEARS	75.30	75.44	75.49	75.56	75.72	75.74	75.81	75.88	75.91	75.96	76.12	76.22
6-10 YEARS	74.01	74.66	75.15	75.47	76.34	75.80	75.40	75.33	75.41	75.57	76.12	76.65
OVER 20 YEARS	78.52	78.71	78.96	79.13	79.84	79.44	79.53	79.68	79.83	79.99	80.24	80.60
1949												
0 MONTH	81.25	81.32	81.40	81.47	81.55	81.63	81.70	81.76	81.83	81.90	81.97	82.04
1-2 YEARS	76.33	76.44	76.52	76.64	76.73	76.88	77.02	77.12	77.17	77.25	77.30	77.39
6-10 YEARS	77.15	77.30	77.80	78.13	78.31	79.08	79.25	79.69	79.63	79.76	79.99	80.30
OVER 20 YEARS	81.03	81.42	81.67	81.75	81.90	82.90	83.51	84.18	84.42	84.62	84.91	85.45
1950												
0 MONTH	82.11	82.18	82.26	82.33	82.41	82.49	82.56	82.64	82.73	82.82	82.90	83.00
1-2 YEARS	77.38	77.43	77.45	77.48	77.67	77.63	77.74	77.72	77.73	77.73	77.85	77.93
6-10 YEARS	80.03	80.21	80.27	80.13	80.99	80.22	80.79	80.81	80.59	80.27	80.33	80.42
OVER 20 YEARS	84.97	84.92	84.76	84.69	84.79	84.58	84.78	85.02	84.74	84.71	84.80	85.00
1951												
0 MONTH	83.09	83.18	83.27	83.37	83.46	83.56	83.66	83.77	83.87	83.98	84.08	84.17
1-2 YEARS	78.01	78.11	77.84	78.03	78.09	78.29	78.52	78.68	78.66	78.78	78.93	78.76
6-10 YEARS	80.72	80.73	79.59	79.95	79.62	79.90	80.47	80.97	80.64	80.83	80.96	80.79
OVER 20 YEARS	85.24	85.19	83.97	82.97	82.72	82.64	83.17	84.52	83.86	83.81	83.09	82.72
1952												
0 MONTH	84.29	84.38	84.47	84.57	84.68	84.80	84.92	85.04	85.16	85.27	85.37	85.50
1-2 YEARS	78.92	78.97	79.22	79.33	79.38	79.35	79.30	79.36	79.49	79.60	79.58	79.67
6-10 YEARS	81.04	80.98	81.52	81.95	81.86	81.73	81.25	81.05	80.64	81.48	81.72	81.79
OVER 20 YEARS	83.24	83.34	83.90	85.46	85.45	85.38	85.29	84.81	83.80	84.85	84.81	84.38
1953												
0 MONTH	85.64	85.76	85.91	86.05	86.19	86.33	86.44	86.58	86.71	86.80	86.87	86.95
1-2 YEARS	79.86	80.01	80.04	79.81	79.76	80.19	80.51	80.79	81.06	81.48	81.60	81.78
6-10 YEARS	81.52	81.32	81.13	80.24	78.61	80.49	81.00	81.00	83.22	83.75	83.79	85.30
OVER 20 YEARS	84.35	83.89	83.53	82.77	82.40	83.06	83.64	84.06	85.91	87.48	87.71	89.46
1954												
0 MONTH	87.04	87.11	87.17	87.24	87.29	87.33	87.37	87.42	87.49	87.53	87.60	87.67
1-2 YEARS	82.31	82.54	82.70	83.03	83.14	83.50	83.62	83.65	83.55	83.45	83.60	83.55
6-10 YEARS	85.66	86.44	87.02	88.09	86.89	88.07	88.00	87.94	87.92	87.79	87.60	87.62
OVER 20 YEARS	90.27	92.45	92.96	93.93	93.12	94.64	95.91	95.55	95.47	95.54	95.29	95.90
1955												
0 MONTH	87.74	87.81	87.89	87.98	88.09	88.16	88.26	88.38	88.52	88.68	89.82	89.97
1-2 YEARS	83.54	83.27	83.40	83.35	83.67	83.53	83.44	83.38	83.85	84.08	83.92	83.97
6-10 YEARS	87.28	86.77	86.97	86.94	87.21	86.74	85.94	86.19	86.95	87.61	87.18	87.10
OVER 20 YEARS	93.59	93.38	93.95	94.09	94.81	94.20	93.34	93.41	94.31	95.34	95.05	95.46

	JAN.	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1956												
0 MONTH	89.15	89.31	89.46	89.62	89.81	89.98	90.15	90.30	90.48	90.68	90.87	91.05
1-2 YEARS	84.51	84.57	84.43	84.18	84.75	85.09	84.98	84.89	85.01	85.32	85.13	85.35
6-10 YEARS	87.90	87.90	86.94	86.58	87.73	87.87	86.91	86.17	86.76	86.75	86.37	86.26
OVER 20 YEARS	96.15	96.22	94.83	93.81	96.00	96.29	94.26	92.39	92.78	92.18	91.58	89.78
1957												
0 MONTH	91.28	91.51	91.72	91.94	92.17	92.40	92.63	92.87	93.10	93.33	93.58	93.78
1-2 YEARS	86.08	86.15	86.47	86.58	86.77	86.80	87.02	87.18	87.30	87.65	88.71	89.42
6-10 YEARS	87.81	87.87	88.05	87.48	87.45	86.57	86.78	87.32	87.14	87.12	90.93	92.29
OVER 20 YEARS	93.10	93.29	93.12	90.92	90.49	88.58	88.57	88.58	89.35	88.94	93.77	96.85
1958												
0 MONTH	93.99	94.10	94.19	94.26	94.35	94.38	94.43	94.49	94.63	94.77	94.89	95.06
1-2 YEARS	90.15	90.72	90.83	91.53	91.83	91.88	91.65	90.00	90.08	90.41	90.81	91.08
6-10 YEARS	92.72	93.87	94.60	95.61	95.84	95.17	94.04	90.61	90.43	90.75	91.68	90.36
OVER 20 YEARS	95.68	97.38	98.53	100.29	101.04	99.12	96.17	92.12	90.97	91.72	93.05	91.17
1959												
0 MONTH	95.24	95.43	95.61	95.79	96.01	96.22	96.43	96.61	96.86	97.14	97.38	97.62
1-2 YEARS	90.92	91.24	91.40	91.56	91.67	91.74	92.01	91.91	91.80	92.81	92.81	92.96
6-10 YEARS	90.32	91.34	90.85	89.75	89.71	89.34	89.22	88.18	88.46	89.73	89.52	87.80
OVER 20 YEARS	90.37	91.12	90.61	89.60	89.47	89.54	90.51	89.27	89.54	90.93	89.99	87.08
1960												
0 MONTH	97.94	98.21	98.52	98.72	98.96	99.15	99.28	99.42	99.56	99.76	99.88	100.00
1-2 YEARS	93.78	94.30	95.69	95.47	95.87	97.19	98.25	98.55	98.89	99.01	98.98	100.00
6-10 YEARS	89.21	90.19	93.51	92.88	93.38	95.13	98.50	98.39	98.69	98.23	97.12	100.00
OVER 20 YEARS	88.20	89.27	93.16	91.58	93.42	96.25	99.55	97.99	98.35	98.14	96.87	100.00
1961												
0 MONTH	100.16	100.33	100.53	100.71	100.86	101.05	101.22	101.35	101.52	101.68	101.85	102.03
1-2 YEARS	99.86	100.03	100.41	100.74	100.80	101.02	101.45	101.50	101.89	102.32	102.49	102.63
6-10 YEARS	99.01	100.37	100.15	100.92	100.75	100.12	99.79	99.90	101.35	101.54	101.15	100.90
OVER 20 YEARS	98.65	101.13	100.72	101.94	101.93	99.88	100.49	99.15	99.71	100.35	100.12	99.36
1962												
0 MONTH	102.24	102.45	102.66	102.88	103.10	103.30	103.55	103.78	104.00	104.24	104.45	104.67
1-2 YEARS	102.85	103.46	104.01	104.25	104.67	104.63	104.81	105.50	105.99	106.25	106.37	106.59
6-10 YEARS	100.71	102.11	103.77	104.82	104.59	103.86	103.96	105.24	105.76	106.75	107.14	107.71
OVER 20 YEARS	99.59	100.15	102.44	104.07	104.10	102.99	102.16	104.68	105.64	106.81	106.96	107.12
1963												
0 MONTH	104.92	105.17	105.42	105.66	105.91	106.16	106.42	106.68	106.96	107.26	107.56	107.84
1-2 YEARS	107.04	107.33	107.52	107.78	107.98	108.25	108.20	108.37	108.79	108.91	109.23	109.42
6-10 YEARS	108.06	108.14	108.33	108.57	108.60	108.60	108.76	108.80	109.17	108.96	109.64	109.74
OVER 20 YEARS	107.11	107.23	107.33	107.15	107.46	107.72	108.21	108.48	108.11	107.54	107.79	107.35
1964												
0 MONTH	108.15	108.45	108.76	109.08	109.37	109.66	109.97	110.25	110.55	110.87	111.18	111.50
1-2 YEARS	109.93	110.07	110.31	110.89	111.28	111.78	112.29	112.46	112.75	113.05	113.10	113.69
6-10 YEARS	109.93	109.93	109.96	110.60	111.30	112.14	112.56	112.67	113.15	113.55	113.59	114.20
OVER 20 YEARS	107.87	107.98	107.63	108.29	109.39	110.27	110.26	110.40	110.71	111.42	111.46	111.68

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1965												
0 MONTH	111.81	112.17	112.53	112.87	113.23	113.58	113.93	114.29	114.64	115.01	115.37	115.73
1-2 YEARS	114.07	114.25	114.72	115.13	115.48	116.00	116.28	116.50	116.59	116.96	117.23	116.77
6-10 YEARS	114.74	114.85	115.42	115.79	116.07	116.65	116.88	116.73	116.42	116.55	116.52	115.14
OVER 20 YEARS	112.27	112.45	113.01	113.44	113.71	114.24	114.35	113.64	112.78	113.07	112.97	111.55
1966												
0 MONTH	116.14	116.56	116.98	117.40	117.84	118.28	118.70	119.14	119.60	120.09	120.55	120.95
1-2 YEARS	117.31	117.71	118.41	118.74	118.93	119.42	119.68	119.31	120.35	121.00	121.40	122.99
6-10 YEARS	114.83	112.98	116.04	116.02	116.13	115.48	114.73	113.39	116.47	117.31	116.92	121.22
OVER 20 YEARS	110.94	107.79	111.09	111.00	110.40	109.76	109.92	108.30	110.87	113.17	111.50	115.94
1967												
0 MONTH	121.40	121.84	122.28	122.68	123.03	123.35	123.72	124.10	124.48	124.90	125.33	125.77
1-2 YEARS	123.99	124.15	125.55	125.81	126.14	125.47	125.99	126.18	126.66	126.78	127.04	127.44
6-10 YEARS	122.72	121.94	124.54	123.11	123.44	120.13	121.69	121.05	121.16	119.61	119.59	120.63
OVER 20 YEARS	118.82	115.80	117.90	114.00	114.24	111.16	112.62	111.71	111.25	107.08	106.36	108.11
1968												
0 MONTH	126.22	126.71	127.19	127.68	128.24	128.81	129.37	129.92	130.44	130.99	131.59	132.10
1-2 YEARS	128.65	129.25	129.30	129.74	130.08	131.03	132.26	132.95	133.42	133.67	134.09	133.23
6-10 YEARS	122.57	122.69	122.32	122.32	122.56	124.14	126.71	127.33	127.65	127.42	127.45	125.09
OVER 20 YEARS	111.66	111.46	108.36	110.28	110.53	113.60	116.29	116.11	114.97	113.36	110.85	106.66
1969												
0 MONTH	132.75	133.39	134.01	134.58	135.25	135.89	136.57	137.31	138.05	138.85	139.59	140.34
1-2 YEARS	133.98	134.50	135.52	136.29	136.15	135.52	135.91	136.51	136.55	138.03	138.14	139.15
6-10 YEARS	125.79	126.43	127.35	127.56	127.27	126.44	127.55	126.96	122.79	128.15	127.44	124.87
OVER 20 YEARS	105.07	105.21	103.95	108.47	103.90	106.20	107.11	106.74	101.02	105.41	102.03	99.44
1970												
0 MONTH	141.08	141.96	142.70	143.47	144.23	145.01	145.71	146.43	147.16	147.86	148.51	149.06
1-2 YEARS	139.13	141.91	143.43	143.19	143.56	145.08	146.49	147.97	149.59	150.72	154.47	154.99
6-10 YEARS	124.33	130.58	131.25	126.66	127.74	129.10	131.71	132.84	135.57	136.65	145.14	146.30
OVER 20 YEARS	100.47	107.65	107.00	102.32	97.68	102.95	106.02	104.81	107.75	107.20	114.91	113.78
1971												
0 MONTH	149.58	150.08	150.47	150.89	151.34	151.84	152.45	153.09	153.65	154.22	154.73	155.23
1-2 YEARS	156.97	159.50	160.15	158.73	158.51	157.79	158.49	160.90	162.29	163.84	165.01	166.13
6-10 YEARS	149.94	151.77	158.17	151.91	150.12	147.38	146.02	154.18	157.42	160.06	160.09	161.81
OVER 20 YEARS	119.77	117.98	123.30	121.23	120.53	119.41	120.39	126.19	128.74	130.77	130.35	130.33
1972												
0 MONTH	155.66	156.04	156.46	156.90	157.32	157.76	158.21	158.67	159.23	159.81	160.41	161.08
1-2 YEARS	166.94	167.86	166.91	168.61	169.58	169.55	170.57	170.59	170.80	171.70	172.92	173.47
6-10 YEARS	160.70	162.75	162.13	163.48	165.25	164.94	165.70	164.73	164.62	166.23	168.51	158.65
OVER 20 YEARS	129.78	131.16	130.53	130.97	134.02	133.46	136.13	137.23	135.90	136.09	141.15	138.01
1973												
0 MONTH	161.71	162.43	163.17	163.96	164.76							
1-2 YEARS	173.45	173.54	173.71	174.88	175.39							
6-10 YEARS	168.08	167.19	167.08	167.83	167.68							
OVER 20 YEARS	131.90	132.63	132.64	135.39	134.36							

*End of Month Values (December 1960 = 100).

Table 4

Distributions of Returns and Adjusted Returns
January, 1947 - May, 1973

Time Series	Pre Tax			Corporate Tax		
	Mean Result	Std.Dev. (Return)	Std.Dev. (Adj.Ret.)	Mean Return	Std.Dev. (Return)	Std.Dev. (Adj.Ret.)
0 Month	0.229%/mo.	0.134	-----	0.114%/mo.	0.066	-----
1 Month	0.250	0.147	0.040	0.125	0.074	0.020
2 Months	0.264	0.161	0.061	0.131	0.084	0.036
3-6 Months	0.261	0.182	0.110	0.126	0.113	0.077
1-2 Years	0.270	0.405	0.374	0.138	0.274	0.258
6-10 Years	0.259	1.191	1.180	0.126	0.896	0.890
Over 20 Years	0.182	1.703	1.703	0.069	1.278	1.278

Table 5

Correlations Among the Time Series of Returns
January, 1947 - May, 1973

	1-2 Years	6-10 Years	Over 20 Years
0 Month	0.588	0.140	0.046
1-2 Years		0.784	0.656
6-10 Years			0.805

Table 6

Slope Coefficients from Regressions of the Time Series of Returns
on the Composite Time Series

0 Month	0.041
1-2 Years	0.511
6-10 Years	1.660
Over 20 Years	2.339

Table 7

Autocorrelation of the Time Series of Returns

	Return	Adjusted Return
0 Month	0.978	---
1 Month	0.896	0.017
2 Months	0.842	0.197
3-6 Months	0.657	0.199
6 Months-1 Yr.	0.393	0.135
1-2 Years	0.281	0.187
2-3 Years	0.181	0.142
3-4 Years	0.194	0.174
4-5 Years	0.158	0.145
5-6 Years	0.030	0.014
6-10 Years	0.030	0.019
10-15 Years	-0.030	-0.032
15-20 Years	-0.041	-0.039
Over 20 Years	-0.032	-0.029

Significance levels of the autocorrelation coefficients-
0.092, 10%; 0.110, 5%; 0.145, 1%.

Table 8

The Initial Maturity of a Security and the Expected
Number of Transactions in a Typical Year

Initial Maturity	Expected Transactions/Year*	
	Buy & Hold	Maturity Maintenance
1 month	12	12
1½ years	0.67	2
8 years	0.13	2
25 years	0.04	2

*There are also two transactions per year for each security
with an original maturity of over a year for reinvestment
of coupons.

Table 9

Performance Over Selected Periods - No Tax - Annual Rates of Return

Initial Term to Maturity	Buy and Hold										
	1/47 to 5/73	1/47 to 3/57	3/51 to 3/53	3/53 to 5/73	3/53 to 5/73	1/61 to 5/73	12/50 to 12/60	12/55 to 12/60	Increasing Interest Rates	Decreasing Interest Rates	Level Interest Rates
1 mo.	2.78	0.94	1.56	3.28	1.98	4.11	1.88	2.36	3.24	3.28	2.47
9 mo.	3.06	0.93	1.83	3.71	2.55	4.65	2.32	2.97	3.32	5.10	3.30
1½ yrs.	3.15	0.93	1.74	3.70	2.60	4.76	2.25	3.37	3.09	6.53	3.80
8 yrs.	2.91	1.11	0.50	4.14	2.89	4.65	2.40	3.07	1.67*	10.52*	5.20*
25 yrs.	2.56	1.43	-0.93*	3.18	2.23	2.57	2.26	0.97	0.94*	8.63*	4.81*

*These results are the same as those for the alternative investment policy in the no tax case because of insufficient resolution among the long term indexes to make a difference over short sample periods. The results are different in the tax cases due to the differential tax patterns associated with each policy.

Table 10

Performance Over Selected Periods - Corporate Tax - Annual Rates of Return

Initial Term to Maturity	Buy and Hold									
	1/47 to 5/73	1/47 to 3/51	3/51 to 3/53	3/53 to 5/73	3/53 to 5/73	1/61 to 5/73	1/61 to 5/73	12/50 to 12/60	12/50 to 12/60	12/55 to 12/60
1 mo.	1.66	0.57	0.78	1.91	1.02	2.33	0.97	1.19	1.54	1.27
9 mo.	1.86	0.63	1.13	2.24	1.39	2.77	1.26	1.54	1.27	1.64
1½ yrs.	1.46	0.47	0.57	1.53	0.89	2.05	0.82	1.29	1.64	-0.15
8 yrs.	1.67	0.66	-0.13	2.46	1.54	2.48	1.29	1.29	1.64	-0.15
25 yrs.	1.36	0.81	-1.36	1.78	1.11	0.76	1.29	1.29	1.64	-0.15

Table 11

Performance Over Selected Periods - No Tax - Annual Rates of Return
Maturity Maintenance

Initial Term to Maturity	1/47 to 5/73	1/47 to 3/51	3/51 to 3/53	3/53 to 5/73	3/53 to 1/61	1/61 to 5/73	12/50 to 12/60	12/55 to 12/60	Increasing Interest Rates	Decreasing Interest Rates	Level: Interest Rates
1 mo.	2.78	0.94	1.56	3.28	1.98	4.11	1.88	2.36	3.24	3.28	2.47
9 mo.	3.21	1.01	1.80	3.88	2.72	4.66	2.41	3.10	3.35	5.23	3.27
1 1/2 yrs.	3.29	1.02	1.25	3.90	2.97	4.76	2.46	3.39	2.98	7.06	3.97
8 yrs.	3.07	1.32	0.25	3.63	2.52	4.23	2.20	2.74	1.67*	10.52*	5.20*
25 yrs.	2.03	1.42	-0.93*	2.35	2.07	2.40	1.64	1.01	0.94*	8.63*	4.81*

*These results are the same as those for the alternative investment policy in the no tax case because of insufficient resolution among the long term indexes to make a difference over short sample periods. The results are different in the tax cases due to the differential tax patterns associated with each policy.

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Table 12

Performance Over Selected Periods - Corporate Taxes - Annual Rates of Return
Maturity Maintenance

Initial Term to Maturity	1/47 to 5/73	1/47 to 3/51	3/51 to 3/53	3/53 to 5/73	3/53 to 1/61	1/61 to 5/73	12/50 to 12/60	12/55 to 12/60
1 mo.	1.66	0.57	0.78	1.91	1.02	2.33	0.97	1.19
9 mo.	2.06	0.71	0.95	2.41	1.58	2.82	1.33	1.60
1 1/2 yrs.	2.05	0.60	0.46	2.28	1.54	2.78	1.29	1.71
8 yrs.	1.87	0.99	-0.24	2.20	1.35	2.25	1.01	1.08
25 yrs.	0.86	0.80	-1.75	0.93	1.12	0.68	0.60	-0.37

APPENDIX

The appendix contains the pre-tax observations for four of the 14 time series from January, 1947 to May, 1973. The observations are in percent per month form.

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1947	0.028	0.029	0.030	0.030	0.029	0.030	0.029	0.030	0.030	0.062	0.065	0.068
0 MONTH												
1-2 YEARS	0.160	0.070	0.135	-0.037	0.101	0.075	0.091	0.106	0.041	-0.071	0.072	0.077
6-10 YEARS	0.421	0.189	0.289	-0.145	0.145	-0.036	0.489	0.420	-0.077	-0.605	-1.000	-2.175
OVER 20 YEARS	0.176	0.365	0.490	-0.006	0.235	-0.372	0.108	0.559	0.021	-0.923	-0.615	-0.940
1948	0.071	0.077	0.078	0.080	0.081	0.081	0.081	0.081	0.087	0.088	0.088	0.090
0 MONTH												
1-2 YEARS	0.146	0.188	0.073	0.093	0.210	0.025	0.092	0.092	0.044	0.065	0.202	0.141
6-10 YEARS	0.418	0.877	0.665	0.419	1.157	-0.708	-0.522	-0.104	0.111	-0.046	0.992	0.698
OVER 20 YEARS	0.206	0.240	0.314	0.213	0.898	-0.492	0.114	0.179	0.198	0.190	0.317	0.449
1949	0.091	0.093	0.092	0.093	0.093	0.092	0.086	0.081	0.083	0.085	0.083	0.085
0 MONTH												
1-2 YEARS	0.133	0.145	0.108	0.159	0.113	0.202	0.174	0.136	0.059	0.111	0.066	0.116
6-10 YEARS	0.647	0.196	0.653	0.414	0.230	0.992	0.208	0.563	-0.085	0.174	0.287	0.380
OVER 20 YEARS	0.530	0.489	0.300	0.103	0.177	1.229	0.738	0.797	0.281	0.244	0.345	0.636
1950	0.086	0.090	0.092	0.091	0.094	0.095	0.095	0.094	0.105	0.107	0.105	0.110
0 MONTH												
1-2 YEARS	-0.015	0.064	0.021	0.044	0.121	0.066	0.152	-0.028	0.008	0.005	0.153	0.107
6-10 YEARS	-0.334	0.231	0.074	-0.178	0.321	-0.206	0.713	0.021	-0.278	-0.398	0.075	0.112
OVER 20 YEARS	-0.562	-0.059	-0.192	-0.080	0.117	-0.253	0.245	0.280	-0.326	-0.036	0.195	0.143
1951	0.111	0.109	0.108	0.122	0.112	0.116	0.122	0.125	0.128	0.133	0.111	0.114
0 MONTH												
1-2 YEARS	0.099	0.122	-0.338	0.239	0.074	0.258	0.304	0.196	-0.021	0.148	0.188	-0.205
6-10 YEARS	0.373	0.003	-1.407	0.447	-0.413	0.360	0.707	0.626	-0.402	0.233	0.154	-0.206
OVER 20 YEARS	0.286	-0.059	-1.429	-1.194	-0.302	-0.101	0.642	1.623	-0.772	-0.064	-0.863	-0.448
1952	0.140	0.108	0.103	0.117	0.132	0.137	0.145	0.149	0.138	0.126	0.124	0.146
0 MONTH												
1-2 YEARS	0.195	0.072	0.312	0.139	0.063	-0.036	-0.067	0.074	0.166	0.134	-0.021	0.120
6-10 YEARS	0.313	-0.079	0.672	0.518	-0.105	-0.154	-0.588	-0.246	-0.503	1.031	0.304	0.076
OVER 20 YEARS	0.636	0.118	0.675	1.862	-0.020	-0.074	-0.105	-0.565	-1.191	1.249	-0.043	-0.505
1953	0.160	0.149	0.165	0.163	0.172	0.154	0.138	0.156	0.146	0.109	0.076	0.098
0 MONTH												
1-2 YEARS	0.229	0.196	0.029	-0.277	-0.065	0.533	0.398	0.352	0.338	0.514	0.142	0.225
6-10 YEARS	-0.331	-0.243	-0.225	-1.097	-2.034	2.392	0.625	0.0	2.747	0.636	0.053	1.794
OVER 20 YEARS	-0.036	-0.547	-0.429	-0.917	-0.445	0.807	0.691	0.501	2.209	1.829	0.259	2.000
1954	0.104	0.078	0.070	0.080	0.053	0.049	0.048	0.053	0.084	0.070	0.061	0.072
0 MONTH												
1-2 YEARS	0.649	0.281	0.196	0.395	0.134	0.428	0.149	0.041	-0.128	-0.117	0.185	-0.059
6-10 YEARS	0.425	0.910	0.670	1.230	-1.365	1.357	-0.078	-0.069	-0.027	-0.149	-0.216	0.029
OVER 20 YEARS	0.902	2.410	0.560	1.038	-0.856	1.625	1.345	-0.371	-0.093	0.075	-0.263	0.645
1955	0.078	0.090	0.088	0.104	0.121	0.085	0.105	0.141	0.161	0.174	0.166	0.164
0 MONTH												
1-2 YEARS	-0.014	-0.328	0.162	-0.062	0.266	-0.046	-0.109	-0.078	0.563	0.272	-0.191	0.070
6-10 YEARS	-0.398	-0.581	0.229	-0.034	0.316	-0.537	-0.932	0.301	0.878	0.759	-0.496	-0.091
OVER 20 YEARS	-2.411	-0.226	0.619	0.149	0.760	-0.644	-0.907	0.073	0.963	1.089	-0.301	0.434

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1956												
0 MONTH	0.199	0.186	0.160	0.180	0.214	0.188	0.192	0.169	0.194	0.221	0.209	0.207
1-2 YEARS	0.644	0.071	-0.174	-0.295	0.675	0.407	-0.126	-0.111	0.140	0.361	-0.218	0.255
6-10 YEARS	0.928	-0.005	-1.087	-0.424	1.333	0.165	-1.098	-0.856	0.690	-0.009	-0.443	-0.128
OVER 20 YEARS	0.718	0.072	-1.448	-1.072	2.335	0.299	-2.104	-1.989	0.422	-0.641	-0.648	-1.966
1957												
0 MONTH	0.250	0.249	0.235	0.233	0.249	0.256	0.250	0.251	0.249	0.250	0.272	0.211
1-2 YEARS	0.863	0.081	0.366	0.133	0.216	0.038	0.253	0.181	0.141	0.404	1.201	0.304
6-10 YEARS	1.805	0.059	0.205	-0.645	-0.036	-1.006	0.245	0.627	-0.215	-0.016	4.376	1.495
OVER 20 YEARS	3.696	0.201	-0.180	-2.367	-0.263	-2.326	-0.009	0.011	0.872	-0.463	5.433	3.283
1958												
0 MONTH	0.221	0.123	0.091	0.080	0.095	0.027	0.056	0.057	0.150	0.146	0.134	0.173
1-2 YEARS	0.821	0.628	0.125	0.765	0.434	-0.045	-0.252	-1.809	0.095	0.370	0.439	0.293
6-10 YEARS	0.467	1.231	0.787	1.059	0.242	-0.698	-1.186	-3.646	-0.204	0.362	1.025	-1.443
OVER 20 YEARS	-1.205	1.781	1.178	1.784	0.751	-1.904	-2.969	-4.221	-1.248	0.828	1.450	-2.024
1959												
0 MONTH	0.193	0.198	0.190	0.194	0.220	0.219	0.221	0.185	0.279	0.273	0.247	0.244
1-2 YEARS	-0.173	0.349	0.183	0.175	0.143	0.084	0.288	-0.106	-0.118	1.103	0.0	0.155
6-10 YEARS	-0.041	1.121	-0.533	-1.206	-0.051	-0.406	-0.137	-1.165	0.317	1.435	-0.229	-1.927
OVER 20 YEARS	-0.867	0.828	-0.564	-1.115	-0.143	0.080	1.085	-1.375	0.308	1.549	-1.036	-3.236
1960												
0 MONTH	0.329	0.280	0.313	0.207	0.240	0.192	0.128	0.145	0.140	0.196	0.124	0.121
1-2 YEARS	0.880	0.564	1.473	-0.234	0.418	1.383	1.089	0.303	0.346	0.123	-0.029	1.027
6-10 YEARS	1.610	1.097	3.679	-0.672	0.540	1.876	3.542	-0.118	0.303	-0.454	-1.130	2.568
OVER 20 YEARS	1.287	1.211	4.366	-1.703	2.014	3.026	3.429	-1.562	0.366	-0.214	-1.297	3.231
1961												
0 MONTH	0.165	0.163	0.201	0.175	0.153	0.186	0.168	0.131	0.164	0.165	0.160	0.182
1-2 YEARS	-0.140	0.174	0.375	0.330	0.058	0.220	0.429	0.050	0.379	0.420	0.167	0.141
6-10 YEARS	-0.993	1.381	-0.224	0.770	-0.166	-0.625	-0.330	0.109	1.448	0.187	-0.382	-0.244
OVER 20 YEARS	-1.354	2.518	-0.404	1.208	-0.085	-2.017	0.611	-1.331	0.568	0.643	-0.233	-0.756
1962												
0 MONTH	0.205	0.202	0.204	0.216	0.221	0.194	0.241	0.218	0.217	0.224	0.204	0.210
1-2 YEARS	0.211	0.593	0.531	0.233	0.402	-0.035	0.167	0.659	0.471	0.238	0.115	0.211
6-10 YEARS	-0.190	1.388	1.629	1.013	-0.223	-0.694	0.089	1.236	0.498	0.928	0.367	0.539
OVER 20 YEARS	0.227	0.561	2.285	1.592	0.031	-1.063	-0.804	2.465	0.914	1.112	0.142	0.148
1963												
0 MONTH	0.242	0.237	0.234	0.233	0.234	0.236	0.245	0.250	0.262	0.261	0.276	0.258
1-2 YEARS	0.416	0.277	0.176	0.240	0.187	0.248	-0.046	0.163	0.380	0.110	0.296	0.175
6-10 YEARS	0.316	0.075	0.179	0.221	0.033	-0.003	0.148	0.037	0.340	-0.198	0.629	0.092
OVER 20 YEARS	-0.011	0.115	0.089	-0.171	0.291	0.244	0.460	0.241	-0.334	-0.438	0.138	-0.408
1964												
0 MONTH	0.285	0.282	0.289	0.289	0.271	0.263	0.278	0.262	0.269	0.288	0.281	0.292
1-2 YEARS	0.464	0.131	0.218	0.529	0.350	0.445	0.457	0.153	0.259	0.263	0.047	0.525
6-10 YEARS	0.169	0.007	0.026	0.580	0.632	0.752	0.375	0.099	0.427	0.353	0.040	0.535
OVER 20 YEARS	0.482	0.107	-0.329	0.618	1.015	0.806	-0.007	0.127	0.280	0.636	0.040	0.195

