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THE TERM STRUCTURE OF INTEREST RATES: U.S. GOVERNMENT BONDS, 1955-1989

by

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Thesis submitted to the Faculty of
Virginia Polytechnic Institute and State University in
partial fulfillment of the requirements for the degree of

MASTER OF ARTS

in

Economics

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May 1990

Blacksburg, Virginia

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(ABSTRACT)

The behavior of the term structure of interest rates in government bonds parallels that of the behavior in high-grade corporate bonds. Previous studies have demonstrated that there are synchronous changes in different maturities in high-grade corporate bonds. Results of statistical tests and measurements of the term structure in U.S. Treasury obligations are compared with previous studies to confirm that the behavior of the yield curve, from the mid-1950's until the 1970's, is consistent with previous norms that there are synchronous changes in all maturities but that there has been an increase in the relative sensitivity of changes in longer term rates since the 1970's per unit change in the short term rates. Generally, all maturities move in the same direction with intermediate and long term rates more synchronous than shorter term rates. Changes in rates are highly correlated across all maturities, but intermediate and short term

rates are somewhat more highly correlated with each other than with long term rates. Also, there is a general tendency for relative volatility to vary inversely with maturity. However, there was an increase in the relative volatility of longer term rates in the 1970's and 1980's. The results are generally consistent with Meiselman's earlier findings for high grade corporate bonds between 1900 and 1954, except for the more recent increase in the volatility of long term U.S. Treasury bonds.

ACKNOWLEDGEMENTS

I would like to extend my appreciation to the thesis committee, Dr. Meiselman, Dr. Mackay, and Dr. Freiden for their comments and suggestions during the preparation of this thesis, and I would especially like to thank Dr. Meiselman for suggesting the topic for my thesis.

My gratitude goes to my family, my sons Daniel and Stefan for their understanding, and most of all to my husband Clifford for his patience and support.

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I. INTRODUCTION

A. Background

The term structure of interest rates is of great practical importance for a general understanding of the dynamics in financial markets. The information incorporated in the term structure is the basis for decisions made by individuals and financial institutions regarding saving, investment, and other elements of inter-temporal choice and capital valuation.

In The Term Structure of Interest Rates (1962), David Meiselman analyzed the yield curve derived from David Durand's "Basic Yields of Corporate Bonds". Changes in the slope of the yield curve were examined, and statistical tests were carried out. Meiselman found that the movements of interest rates of all maturities were dependably synchronous, with the magnitude of change inversely and functionally related to maturity. The shorter the term to maturity the greater the relative change in rates, and vice versa. Thus, the yield curve could be described in terms of a family of rates in which changes in each member or maturity is dependably related to changes in each other.[1]

This paper describes an analysis in which Meiselman's approach is applied to a different body of data and a different time period, specifically government bond data from 1955 to 1989. The results are compared with those in Meiselman's study. The purpose of this paper is to examine changes in the yield curve, to test whether changes in different maturities are synchronous, and to measure relative magnitudes of change to test whether there is a regular pattern of change by maturity classification. An effort is made to determine whether the behavior of the term structure of interest rates in government bond data display the same characteristics as the 1900-1954 corporate bond data. Further, this study will examine whether differences in behavior, should they exist, are systematic or random occurrences.

The corporate bond yield series developed by Durand and used in Meiselman's study was assumed to have a negligable (but not zero) default risk. Selected corporate interest rate data were interpolated and fitted by hand, and the resulting curve was a smoothed yield curve. The yield curve in this paper is derived by the Board of Governors of the Federal

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[1] David Meiselman, The Term Structure of Interest Rates (Englewood Cliffs, 1962), p.22.

Reserve System. The data are published regularly in The Federal Reserve Bulletin and in Federal Reserve statistical releases. Default risk is essentially non-existent. Calculations and curve-fitting are carried out with the use of sophisticated computer programs.

B. Definitions

Term Structure

The term structure of interest rates is defined as the relationship between yield and maturity for securities that are alike in all aspects except the length of time to maturity.[2] The term structure at any given date is determined by bond prices quoted on that day. There is some consensus that the prices and yields of these securities are determined by the market's expectations, as well as by the amount of risk aversion of market participants.[3]

Bonds

A bond is a debt obligation of the issuer. When the bond is mature, the issuer pays accumulated interest and principal

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[2] Robert J. Shiller and Huston J. McCulloch, "The Term Structure of Interest Rates" (Washington, 1987), p.11.

[3] Tim S. Campbell, Money and Capital Markets (Glenview,1988), p.53.

to the bondholder. At time t of a bond maturing at time T, the purchaser pays price p(t,T) and is entitled to receive payments corresponding to the t_i that are greater than t, so long as the purchaser continues to hold the bond. Two kinds of payment sequences are common: 1. Discount bonds consist of a single payment, the principal, paid at maturity. 2. Coupon bonds promise a payment at regular time intervals of a certain amount, plus a payment of the last coupon and the principal at the maturity date. This study considers both coupon bonds and discount bonds. The discount bonds have, however, been converted to coupon equivalent bonds in this study.[4]

The Yield Curve

The relationship between yield and maturity at time t to term m is given by r(t,t+m). A plot of this function is known as a yield curve. A yield curve is commonly plotted with maturity along the x-axis, and yield along the y-axis. A "normal" yield curve is a positive one, where the long term rates are higher than the short term rates, and the rates are systematically higher as term to maturity increases. When short term rates are higher than long term rates, the result

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[4] Marcia Stigum, Money Market Calculations (Homewood,1981), p.32.

is a downward or negatively sloped yield curve. A humped curve indicates that intermediate rates are higher than either long term or short term rates.

A conventional interpretation of the movements in the term structure, and the slope of the yield curve, is that market expectations cause changes in interest rates by directing investors' decisions. From 1900 to the mid-1920's, the yield curve generally had a negative slope.[5] By the late 1920's the yield curve had a positive slope and although the curve shifted up and down, it generally remained positively sloped until the 1970's.

In the 1970's a more varied pattern emerged. In August 1974, for example, the yield curve exhibited a negative slope, but a positive one in May 1975. In early 1980's the yield curve was negatively sloped, where short term rates were higher than long term rates.[6] In June 1989 the yield curve was nearly horizontal.

If changes in specific maturities are synchronous, changes in the slopes of the yield curve is a function of the relative changes in volatility. When rates were historically low, the yield curve was positively sloped because short rates

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5 Meiselman, p.42.

6 Frederick T. Furlong, "Weekly Letter" (San Francisco,1989), p.2.

fell more than long rates, driving short rates below long rates. When rates are historically high, the yield curve had a negative slope for a mirror image based on the same mechanism. We shall see that there was a shift in behavior in the 1970's that resulted from a change in the volatility of long term rates and intermediate rates, relative to short term rates.

II. DATA

A. Description

This study examines U.S. Treasury obligations of eleven different maturities. The observation period ranges from 12 years to 34 years, beginning on or after January 1955, and ending on or before June 1989. The monthly data are monthly averages of daily figures (Board of Governors of The Federal Reserve System, Domestic Financial Statistics; Interest Rates, Money and Capital Markets). The shortest maturity included in the study is 3 months, and the longest maturity is 30 years (Table I). There is a difference in the number of observations for bonds of different maturities resulting from the different dates that specific maturities were first measured and counted. The 12 month bond, for example was first included in February 1960, and the 2 year bond yield was first included beginning only in June 1976, thus resulting in a difference of 197 observations, or an equivalent number of months.

Meiselman's data set consists of high-grade corporate bond data, where observations had been taken once a year between 1900 and 1954. Tax effects were not considered, and default risk was essentially neglected. Because the present sample consists of monthly observations, there is more noise in this study than in Meiselman's sample of yearly figures.

B. Overview of Analyses

All data was entered into Lotus 1-2-3 (Lotus Development Corporation, Release 2.01). This software was used to carry out all calculations, counts, and regressions. First differences were determined for each maturity by calculating first difference changes in yield (per cent) per month.

Sign Test

Changes in the interest rate of maturity A and maturity B are compared via sign tests. A change is recorded as "+" when it is positive, " -" when it is negative, and " 0" when it is zero. These signs are compared monthly for all combinations of two maturities, and matches are counted. The results are arranged into matrices of matching sign counts. Each cell in a matrix consists of the count, in absolute numbers and in per cent, of total monthly pairs checked of positive, negative- or zero-change matches.

Synchronization

To find whether the term structure exhibits synchronous movement, i.e. where two or more rates move in the same direction, the sums of the diagonal entries are examined. These sums show how often rates move together, i.e. in the same direction. The synchronization among individual maturities is also compared for times when the majority of rates increase, decrease, or remain unchanged.

Regression-Correlation

In order to obtain a sample size which is relatively uniform across the maturities considered, seven out of eleven maturities are initially included in a regression-correlation analysis. While the 12 month, 2 year, 7 year and 30 year maturities are omitted because of the small number of observations relative to the other seven maturities, a separate regression analysis is carried out on all eleven maturities. In order to examine movements in the term structure during different time periods, regression is run for the whole time period under study, 1955-1989, and for several sub-periods, in order to closely examine whether significant changes in term structure took place during any of the subperiods. In addition, in order to directly compare these results with Meiselman's, correlation-regression analysis of year-end data is carried out using December figures from each year included in the sample.

The linear regression-correlation analysis is fit to data consisting of all monthly pairs of changes in first differences for each combination of two maturities. It results in regression coefficients relating changes in interest rate between all combinations of two maturities, a correlation coefficient for each combination of two maturity changes, and an intercept value for each pairing. The regression equation is

$$(C_B)_m = R_{BA}(C_A)_m + c \qquad (1)$$

where $(C_A)_m$ = change in first difference of interest rate for maturity A at month m

c = constant term

R_{BA} = regression coefficient of B on A

Table 1. NUMBER OF OBSERVATIONS OF A GIVEN MATURITY.

Maturity	Number of observations
3 Mo	415
6 Mo	362
12 Mo	350
1 Yr	415
2 Yr	153
3 Yr	415
5 Yr	415
7 Yr	236
10 Yr	415
20 Yr	382
30 Yr	146

III. Analysis

Sign Tests

Results of sign tests for all maturities over the period 1955-1989 are given in Tables 2, 3, 4, 5, and 6. An examination of the synchronization of signs clearly indicates that simultaneous change among the various maturities take place. Simultaneous positive changes dominate the pattern where the intermediate maturities move together more frequently than the shortest and the longest ones, and no change in sign occurs with the lowest frequency. In his sample, Meiselman found that rates tend to move together both at the short end and the long end.

Synchronization

Diagonal sums of matrices containing counts of simultaneous positive, negative, or no-change signs are indicative of yield curve behavior. A comparison of results for all maturities over the period 1955-1989 confirms the theory that rates tend to move in a regular and synchronized manner (Tables 7, 8, 9, and 10). Again, the intermediate rates tend to move together more frequently than the shorter and longer rates. Synchronized movement among the 1 year, 2 year, 3 year, 5 year, and 7 year rates is apparent more than

90 % of the available paired monthly observations. Lower percentage of synchronization is found when matching a short maturity with a long one, such as a 3 month maturity and 20 year maturity, which move together only 57 % of the time. When the majority of rates increase, the intermediate rates, (1 year, 3 years, and 5 years) tend to increase more often than the other rates. The same behavior can be found when the majority of rates decrease (Tables 11, 12, 13, and 14).

Regression-Correlation: Seven Selected Maturities, 1955-1989

Regression-correlation analysis carried out on the seven maturities on the whole period shows high and positive correlation between the changes in the first differences in the given maturities. Correlation and regression coefficients are shown in Table 15. Regression always produces an intercept which is essentially zero. The correlation coefficient ranges between .98 (3 year and 5 year maturities), and .59 (6 months and 20 years). A separate correlation-regression analysis carried out for year-end data shows an almost identical pattern to that for the period 1955-1989 (Table 16).

Regression-Correlation: Seven Selected Maturities, Subperiods

Sometimes changes occurring in otherwise regular behavior can be detected when subperiods are examined. In the 1960's only the intermediate maturities show high correlation, and the values of the regression coefficients are lower than for the whole period between 1955-1989 (Table 17). Greater variability in the term structure appears in the early 1970's. Intermediate rates, such as the 3 year, and 5 year rates, remain highly correlated whereas the other maturities exhibit an irregular pattern compared with the regularity over the whole observation period (Table 18). Between the years 1980-1989 correlation coefficients are high and a regularity in pattern returns. The maturities in the period 1980-1989 show correlation and regression coefficients having higher values than during the other sub-periods or the whole period under study (Table 19 and Table 20).

Separate regression-correlation analyses are carried out on the periods 1955-1972 and 1973-1989 (Table 21 and Table 22). Intermediate rates produce high correlation and regression coefficients between the years 1955-1972, as was the case during some parts of the sub-periods of 1960-1969 and 1970-1979.

Regression-Correlation: All Maturities, 1977-1989

Correlation-regression analysis on all maturities between the years 1977-1989 produces a pattern similar to the subperiods 1970-1979 and 1980-1989. The values of the correlation and regression coefficients are high during this period (Table 23 and Table 24).

Table 2. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989. Monthly figures, classified by maturity.

	Maturity A										
Maturity B	3mo	6	12	1	2	3	5	7	10	20	30
3mo	415										
6	181	362									
12	159	168	350								
1yr	190	162	178	415							
2	71	73	75	77	153						
3	178	171	167	180	80	415					
5	170	161	156	198	77	211	415				
7	99	103	105	109	77	117	118	236			
10	165	155	149	192	76	202	208	117	415		
20	147	138	133	173	57	180	182	97	190	382	
30	64	66	67	69	70	74	74	76	76	65	146

The data represent the simultaneous positive matches for various maturities.

Table 3. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989. Monthly figures, in per cent, classified by maturity.

Maturity B \ Maturity A	3	6	12	1	2	3	5	7	10	20	30
3	100										
6	50	100									
12	50	48	100								
1	46	45	51	100							
2	46	48	50	50	100						
3	43	47	48	43	52	100					
5	41	44	45	48	50	51	100				
7	42	44	44	46	50	50	50	100			
10	40	40	43	46	50	49	50	50	100		
20	38	38	38	45	37	47	48	41	50	100	
30	44	45	46	47	48	51	51	52	52	45	100

The data represent (in % of total positive signs) the simultaneous positive matches for the various maturities.

Table 4. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989. Monthly figures, classified by maturity.

Maturity B \ Maturity A	3	6	12	1	2	3	5	7	10	20	30
3	415										
6	129	362									
12	133	134	350								
1	134	135	143	415							
2	52	55	63	63	153						
3	127	128	138	153	64	415					
5	118	118	127	140	62	162	415				
7	83	86	96	95	62	103	104	236			
10	108	108	117	132	62	147	151	103	415		
20	104	101	108	124	48	134	135	88	138	382	
30	37	40	47	47	49	51	51	53	54	46	146

The data represent the simultaneous negative matches for various maturities.

Table 5. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989. Monthly figures, in per cent, classified by maturity.

Maturity B \ Maturity A	3	6	12	1	2	3	5	7	10	20	30
3	100										
6	36	100									
12	38	38	100								
1	32	36	41	100							
2	34	34	41	41	100						
3	31	35	39	37	42	100					
5	28	33	36	34	41	39	100				
7	35	36	41	40	41	44	44	100			
10	26	30	33	32	41	35	36	44	100		
20	27	28	31	32	31	35	35	37	36	100	
30	25	27	32	32	33	35	35	36	37	32	100

The data represent (in % of total negative signs) the simultaneous negative matches for various maturities.

Table 6. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989. Monthly figures, classified by maturity.

Maturity B \ Maturity A	3	6	12	1	2	3	5	7	10	20	30
3	415										
6	1	362									
12	0	0	350								
1	0	1	0	415							
2	0	0	0	1	153						
3	0	0	0	0	0	415					
5	3	1	1	1	0	0	415				
7	1	0	0	0	0	0	1	236			
10	2	1	0	0	0	1	4	1	415		
20	2	0	1	2	0	0	3	0	3	382	
30	0	0	0	0	0	0	0	0	0	0	146

The data represent simultaneous no-change matches for various maturities.

Table 7. SYNCHRONOUS MOVEMENT IN INTEREST RATES, 1955-1989. Monthly figures, classified by maturity.

Maturity B \ Maturity A	3	6	12	1	2	3	5	7	10	20	30
3	415										
6	277	362									
12	262	302	350								
1	303	308	321	415							
2	118	128	138	140	153						
3	264	300	305	333	144	415					
5	286	280	283	307	139	347	415				
7	165	190	201	204	139	220	223	236			
10	261	263	266	310	138	312	346	221	415		
20	218	239	242	299	105	314	319	185	329	382	
30	96	106	114	116	119	125	125	129	130	111	146

The data represent the diagonal sums of matrices containing the number of simultaneous positive, negative and no-change matches for various maturities.

Table 8. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989. Monthly figures, in per cent, classified by maturity.

	Maturity A										
Maturity B	3	6	12	1	2	3	5	7	10	20	30
3	100										
6	77	100									
12	75	86	100								
1	73	85	92	100							
2	73	84	90	92	100						
3	64	83	87	80	94	100					
5	69	77	81	74	91	84	100				
7	70	81	85	86	91	93	94	100			
10	63	73	76	75	90	75	83	94	100		
20	57	66	69	78	69	82	84	78	86	100	
30	66	73	78	79	82	86	86	88	89	76	100

The data represent (in %) the diagonal sums of matrices containing the number of positive, negative, and no-change matches for the various maturities.

Table 9. NON-SYNCHRONOUS MOVEMENT IN INTEREST RATES, 1955-1989. Monthly figures, classified by maturity.

Maturity B	Maturity A: 3	6	12	1	2	3	5	7	10	20	30
3	415										
6	85	362									
12	90	48	350								
1	112	54	29	415							
2	35	25	15	13	153						
3	151	62	45	82	9	415					
5	129	82	67	108	14	68	415				
7	71	46	35	32	14	16	13	236			
10	154	99	84	105	15	103	69	15	415		
20	164	123	108	83	48	68	63	51	53	382	
30	50	40	32	30	27	21	21	17	16	35	146

The data represent the number of times signs move in opposite directions.

Table 10. NON-SYNCHRONOUS MOVEMENT IN INTEREST RATES, 1955-1989. Monthly figures, in per cent, classified by maturity.

Maturity B \ Maturity A	3	6	12	1	2	3	5	7	10	20	30
3	100										
6	23	100									
12	25	14	100								
1	27	15	8	100							
2	27	16	10	8	100						
3	36	17	13	20	6	100					
5	31	23	19	26	9	16	100				
7	30	19	15	14	9	7	6	100			
10	37	27	24	25	10	25	17	6	100		
20	43	34	31	22	31	18	16	22	14	100	
30	34	27	22	21	18	14	14	12	11	24	100

The data represent (in %) the movement of signs in opposite directions.

Table 11. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989
Monthly figures converted to years, classified by maturity.

a. When Majority of Rates Increased (18 years)

Years to Maturity	3mo	6	12	1yr	2	3	5	7	10	20	30	
Number of Times Rate												Sum
Increased	13	13	13	15	6	16	15	9	15	13	5	133
Unchanged	0	0	0	0	0	0	0	0	0	1	0	1
Decreased	3	2	1	2	0	1	1	1	2	1	0	14

b. When Majority of Rates Decreased (15 years)

Years to Maturity	3mo	6	12	1yr	2	3	5	7	10	20	30	
Number of Times Rate												Sum
Increased	3	1	0	1	0	0	0	0	1	1	0	7
Unchanged	0	0	0	0	0	0	0	0	0	0	0	0
Decreased	11	12	12	14	6	14	14	9	13	12	5	122

Table 12. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989
Monthly figures converted to years, classified by maturity.
Rates are expressed in per cent.

a. When Majority of Rates Increased (18 years)

Years to Maturity	3mo	6	12	1yr	2	3	5	7	10	20	30
Change in Rate in %											
Increased	72	87	87	73	100	89	84	90	84	81	83
Unchanged	0	0	0	0	0	0	0	0	0	0	1
Decreased	16	13	6	11	0	5	5	10	11	6	0

b. When Majority of Rates Decreased (15 years)

Years to Maturity	3mo	6	12	1yr	2	3	5	7	10	20	30
Change in Rate in %											
Increased	16	6	0	6	0	0	0	0	6	6	0
Unchanged	0	0	0	0	0	0	0	0	0	0	0
Decreased	61	80	80	78	99	78	78	90	72	75	83

Table 13. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989
Monthly figures converted to years, classified by maturity.

a. When Majority of Rates Increased (18 years)

Years to Maturity	3mo	6	1yr	3	5	10	20	
Number of Times Rate								Sum
Increased	10	11	15	16	16	16	16	100
Unchanged	1	0	0	0	0	0	0	1
Decreased	7	1	2	0	0	1	1	12

b. When Majority of Rates Decreased (15 years)

Years to Maturity	3mo	6	1yr	3	5	10	20	
Number of Times Rate								Sum
Increased	7	2	1	0	0	0	0	10
Unchanged	0	0	0	0	0	0	0	0
Decreased	7	12	14	14	14	13	13	87

Table 14. SYNCHRONIZATION OF INTEREST RATE CHANGES, 1955-1989
Monthly figures converted to years, classified by maturity.
Rates are expressed in per cent.

a. When Majority of Rates Increased (18 years)

Years to Maturity	3mo	6	1yr	3	5	10	20
Change in Rate in %							
Increased	56	61	83	89	89	89	89
Unchanged	1	0	0	0	0	0	0
Decreased	39	1	1	0	0	1	1

b. When Majority of Rates Decreased (15 years)

Years to Maturity	3mo	6	1yr	3	5	10	20
Change in Rate in %							
Increased	47	13	1	0	0	0	0
Unchanged	0	0	0	0	0	0	0
Decreased	47	80	93	93	93	87	87

Table 15. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, 1955-1989. Changes are based on monthly figures.

a. Correlation Coefficient

Maturity B	Maturity A: 3	6	1	3	5	10	20
3	1						
6	.81	1					
1	.90	.82	1				
3	.78	.74	.95	1			
5	.72	.71	.91	.98	1		
10	.62	.60	.81	.90	.93	1	
20	.61	.59	.79	.88	.91	.93	1

b. Regression Coefficient

Maturity B	Maturity A: 3	6	1	3	5	10	20
3	1						
6	.96	1					
1	.82	.62	1				
3	.57	.45	.76	1			
5	.46	.37	.64	.86	1		
10	.34	.28	.49	.68	.80	1	
20	.28	.23	.40	.57	.68	.80	1

Table 16. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, YEAR-END DATA, 1955-1989. Changes are based on monthly figures.

a. Correlation Coefficient

Maturity B \ Maturity A	3	6	1	3	5	10	20
3	1						
6	.97	1					
1	.92	.96	1				
3	.78	.85	.94	1			
5	.71	.80	.90	.99	1		
10	.62	.71	.83	.96	.98	1	
20	.58	.68	.77	.90	.93	.95	1

b. Regression Coefficient

Maturity B \ Maturity A	3	6	1	3	5	10	20
3	1						
6	.91	1					
1	.80	.89	1				
3	.58	.67	.81	1			
5	.49	.59	.72	.92	1		
10	.39	.47	.59	.80	.88	1	
20	.30	.38	.47	.65	.73	.85	1

Table 17. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, 1960-1969. Changes are based on monthly figures.

a. Correlation Coefficient

Maturity B	Maturity A: 3	6	1	3	5	10	20
3	1						
6	.67	1					
1	.86	.66	1				
3	.70	.60	.88	1			
5	.64	.55	.82	.96	1		
10	.51	.65	.66	.80	.85	1	
20	.42	.59	.65	.78	.81	.78	1

b. Regression Coefficient

Maturity B	Maturity A: 3	6	1	3	5	10	20
3	1						
6	.86	1					
1	.86	.51	1				
3	.62	.41	.78	1			
5	.49	.33	.63	.82	1		
10	.36	.47	.47	.64	.79	1	
20	.20	.22	.31	.42	.51	.53	1

Table 18. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, 1970-1979. Changes are based on monthly figures.

a. Correlation Coefficient

Maturity B \ Maturity A	3	6	1	3	5	10	20
3	1						
6	.60	1					
1	.87	.60	1				
3	.76	.52	.93	1			
5	.70	.48	.89	.98	1		
10	.53	.38	.67	.76	.79	1	
20	.57	.40	.72	.78	.80	.77	1

b. Regression Coefficient

Maturity B \ Maturity A	3	6	1	3	5	10	20
3	1						
6	.86	1					
1	.85	.33	1				
3	.53	.22	.73	1			
5	.43	.18	.60	.83	1		
10	.27	.12	.39	.57	.68	1	
20	.22	.15	.32	.44	.53	.58	1

Table 19. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, 1980-1989. Changes are based on monthly figures.

a. Correlation Coefficient

Maturity B \ Maturity A	3	6	1	3	5	10	20
3	1						
6	.98	1					
1	.92	.98	1				
3	.81	.89	.96	1			
5	.74	.84	.92	.99	1		
10	.66	.77	.86	.95	.98	1	
20	.63	.73	.83	.91	.95	.98	1

b. Regression Coefficient

Maturity B \ Maturity A	3	6	1	3	5	10	20
3	1						
6	.94	1					
1	.81	.89	1				
3	.57	.65	.77	1			
5	.46	.54	.65	.87	1		
10	.35	.42	.52	.72	.84	1	
20	.30	.35	.44	.63	.75	.91	1

Table 20. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, 1982-1989. Changes are based on monthly figures.

a. Correlation Coefficient

		Maturity A						
		3	6	1	3	5	10	20
Maturity B	3	1						
	6	.93	1					
	1	.83	.97	1				
	3	.69	.87	.95	1			
	5	.62	.81	.91	.99	1		
	10	.56	.76	.87	.96	.99	1	
	20	.54	.72	.82	.92	.95	.98	1

b. Regression Coefficient

		Maturity A						
		3	6	1	3	5	10	20
Maturity B	3	1						
	6	.90	1					
	1	.79	.94	1				
	3	.62	.80	.90	1			
	5	.53	.72	.82	.94	1		
	10	.45	.63	.74	.86	.93	1	
	20	.38	.54	.64	.78	.86	.94	1

Table 21. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, 1955-1972. Changes are based on monthly figures.

a. Correlation Coefficient

Maturity B	Maturity A: 3	6	1	3	5	10	20
3	1						
6	.78	1					
1	.85	.80	1				
3	.73	.73	.91	1			
5	.67	.69	.86	.98	1		
10	.48	.38	.62	.72	.75	1	
20	.46	.47	.66	.72	.74	.68	1

b. Regression Coefficient

Maturity B	Maturity A: 3	6	1	3	5	10	20
3	1						
6	.87	1					
1	.83	.69	1				
3	.61	.56	.79	1			
5	.49	.46	.65	.85	1		
10	.33	.25	.44	.59	.72	1	
20	.21	.20	.31	.39	.45	.44	1

Table 22. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, 1973-1989. Changes are based on monthly figures.

a. Correlation Coefficient

Maturity B	Maturity A: 3	6	1	3	5	10	20
3	1						
6	.82	1					
1	.91	.82	1				
3	.79	.74	.96	1			
5	.73	.69	.92	.98	1		
10	.65	.64	.85	.94	.97	1	
20	.63	.61	.81	.90	.94	.98	1

b. Regression Coefficient

Maturity B	Maturity A: 3	6	1	3	5	10	20
3	1						
6	.97	1					
1	.82	.62	1				
3	.56	.44	.75	1			
5	.45	.36	.63	.86	1		
10	.34	.28	.49	.70	.82	1	
20	.29	.23	.42	.60	.72	.90	1

Table 23. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, 1977-1989. Changes are based on monthly figures.

a. Correlation Coefficient

		Maturity A										
		3	6	12	1	2	3	5	7	10	20	30
Maturity B	3	1										
	6	.80	1									
	12	.92	.81	1								
	1	.92	.81	1	1							
	2	.85	.76	.98	.98	1						
	3	.81	.74	.96	.96	.99	1					
	5	.75	.69	.92	.92	.97	.98	1				
	7	.69	.65	.88	.88	.94	.96	.99	1			
	10	.67	.64	.86	.86	.92	.95	.98	.99	1		
	20	.64	.60	.82	.82	.88	.91	.95	.97	.98	1	
	30	.62	.59	.81	.81	.87	.91	.94	.97	.98	.99	1

Table 24. RELATIONS OF FIRST DIFFERENCES OF INTEREST RATES OF ALTERNATIVE MATURITIES, 1977-1989. Changes are based on monthly figures.

b. Regression Coefficient

Maturity B	Maturity A: 3	6	12	1	2	3	5	7	10	20	30
3	1										
6	.97	1									
12	.88	.64	1								
1	.82	.60	.93	1							
2	.66	.49	.80	.86	1						
3	.57	.43	.71	.76	.89	1					
5	.46	.36	.60	.65	.77	.87	1				
7	.40	.31	.53	.57	.69	.79	.91	1			
10	.36	.28	.48	.52	.63	.72	.84	.92	1		
20	.30	.23	.41	.44	.54	.63	.74	.83	.91	1	
30	.29	.23	.40	.43	.53	.61	.71	.79	.86	.94	1

IV. CONCLUSION

A comparison with Meiselman's study of the term structure of interest rates in corporate bond yields, and government bond yields in this paper, confirms that the term structures behave in a similar manner. Examination of the movements in the yield curve over the entire period of study shows that the rates move together in a synchronized, and relatively regular manner. The intermediate rates in the government bond yields tend to exhibit the highest degree of synchronization.

The correlation analysis for the whole period of study conform, with some exceptions, to those of Meiselman. The inverse relationship between correlation and term to maturity holds, except that the intermediate rates in this sample also produce the highest correlation coefficients. Examination of sub-periods demonstrates that greater volatility than over the entire period, appears in the 1970's and continues into the 1980's with higher values of correlation and regression coefficients.

The change in the behavior of the yield-curve from regularity into volatility may be due to the large movements in market interest rates during that time period. Short term rates, which historically had been more volatile than long term rates, became relatively less volatile, and more movement took place in the long term rates as well as in the intermediate rates.

An examination of the regression coefficients in Table 25 demonstrates that an inverse relationship exists between volatility and time to maturity, with systematically greater volatility the longer the maturity. Each maturity is a scalar of another, and the changes in one are in proportion to the changes in the other.

The greater variability in the term structure of government bond yields may be due to the fact that this sample contains monthly figures in contrast to Meiselman's study where yearly figures were recorded. The general pattern of movement in the term structure of interest rates of government bond yields tends, however, to parallel that of corporate bond yields where rates move together in a synchronized manner and a dependable relationship is evident between relative changes and maturity.

Table 25.

a. RELATIONSHIP BETWEEN CHANGES IN LONG-TERM INTEREST RATES OF SELECTED MATURITIES AND CHANGES IN ONE-YEAR INTEREST RATES, MONTHLY FIGURES, 1955-1989

Time to Maturity	a	b	Correlation Coefficient
3 mo	.00	.82	.90
6 mo	.01	.62	.82
3 yrs	.00	.76	.95
5 yrs	.00	.64	.91
10 yrs	.01	.49	.81
20 yrs	.01	.40	.79

b. RELATIONSBETWEEN CHANGES IN LONG-TERM DEFAULT-FREE INTEREST RATES OF SELECTED MATURITIES AND UNANTICIPATED CHANGES IN DEFAULT-FREE ONE-YEAR INTEREST RATES, ANNUAL FIGURES, 1901-1954 (Meiselman, 1962).

Years to Maturity	a	b	Correlation Coefficient
5	.05	.48	.87
10	.04	.36	.84
15	.03	.30	.84
20	.03	.26	.83
25	.03	.26	.83
30	.03	.25	.82

Source:
Meiselman, David., The Term Structure of Interest Rates, Prentice Hall, Englewood Cliffs, N.J. 1962.

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