The Maturity Structure of Term Premia with Time-Varying Expected Returns

by Mark A. Hooker

Federal Reserve Bank of Boston

No. 96-4 August 1996

Working Paper Series

The Maturity Structure of Term Premia with Time-Varying Expected Returns

by Mark A. Hooker

August 1996
Working Paper No. 96-4

Federal Reserve Bank of Boston

The Maturity Structure of Term Premia with Time-Varying Expected Returns*

Mark A. Hooker

Department of Economics
Wellesley College

August, 1996

JEL classification codes E43, G12

Abstract:

This paper analyzes the maturity structure of term premia using McCulloch's U.S. Treasury yield curve data from 1953-91, allowing expected returns to vary across time. One-, three-, six- and twelve-month holding period returns on maturities up to five years are projected on three *ex ante* variables to compute time-varying expected returns, and simulations are employed to evaluate econometrically nonstandard constraints. The likelihood of expected returns monotonically increasing in maturity (as implied by the liquidity preference hypothesis) is found to vary systematically across values of the *ex ante* variables and by holding period. Monotonicity is associated primarily with a steep yield curve, high interest rates, and longer holding periods, while the hypothesis that nonmonotonic (hump-shaped) maturity-return profiles are correlated with the onset of recessions does not receive much support.

Key words: Term structure, time-varying returns, liquidity preference.

---

* Much of this paper was written while the author was a visiting scholar at the Federal Reserve Bank of Boston. The views expressed here are not necessarily those of the Federal Reserve Bank of Boston or the Federal Reserve System. I thank seminar participants at UC Santa Barbara and the summer 1996 Econometric Society meetings for helpful comments. Address correspondence to: Mark Hooker, Department of Economics, Wellesley College, Wellesley MA, 02181. Phone (617) 283-2493, e-mail mhooker@wellesley.edu.

I. Introduction

The liquidity preference hypothesis (LPH) asserts that expected returns on bonds of different maturity but equal default risk, over a given-length holding period, are monotonically increasing in maturity. The reasoning is that shorter maturity assets are more liquid (ceterus paribus), having lower price volatility and transactions costs, and so compensate their holders partly in the form of nonpecuniary "monetary services."[1] It is a strong hypothesis—finance theory does not generally impose restrictions on the shape of the maturity-return relationship—but several authors have found empirical support for it.

The LPH is also an econometrically nonstandard hypothesis, as it involves multiple inequality constraints. Perhaps for this reason, in tests it has generally been simplified in two important ways. The first of these is to test a weaker version of the hypothesis, commonly whether expected returns on a given maturity bond are greater than on the one-period-less maturity bond. The second, from the expectations hypothesis of the term structure, is to assume in addition that expected holding period returns are constant across time.[2]

These simplifications are restrictive, both theoretically and empirically. The LPH constrains the full spectrum of maturities and not just neighboring pairs. Empirically, average holding period returns on U.S. bonds frequently decline across three or more successive maturities, suggesting that expected returns may, as well.

Several results in theoretical and empirical finance cast doubt on the likelihood that expected returns are constant across time. Intertemporal CAPM-type models imply that the returns to bearing a given amount of risk should move with the marginal utility of consumption or other state variables, and thus will generally fluctuate across time. On the

[1] There are a number of definitions of the term liquidity. The one that most closely matches that incorporated in the LPH seems to be Keynes's, where an asset is more liquid if it is "more certainly realizable at short notice without loss" (1930, p. 67). Lippmann and McCall (1986) and Hooker and Kohn (1995) provide measures of this concept of liquidity, and discuss how it relates to other definitions.

[2] The "pure" expectations hypothesis asserts that term premia are all zero. This extreme version has almost no empirical support and is not commonly used. There are several closely related, but distinct versions of the expectations hypothesis and corresponding definitions of term premia; this version (expressed in terms of expected holding period returns) is the one most commonly analyzed in financial economics.

empirical side, a great deal of evidence has accumulated that holding period returns on bonds are predictable using *ex ante* values of variables which fluctuate across time. Forward rates, measures of the slope of the yield curve, spreads between yields on default-free and risky securities, measures of volatility, and other variables have been shown to reliably forecast returns on default-free bonds over a wide range of sample periods.[3] This implies that expected returns themselves are time-varying.

If returns were assumed to be constant across time, then methods like those employed by Richardson, Richardson and Smith (1992) could be used to test the full set of LPH constraints. However, in the case of time-varying returns, the theory constrains predicted values from a multivariate regression, so classical methods do not appear to be applicable. The method proposed in this paper is to use the information about the first and second moments of expected returns which is contained in projections of observed returns onto *ex ante* variables. This approach is related to some recently proposed simulation methods for testing calibrated models. In this work,[4] data are generated from a model with particular parameter values (which may be drawn from a distribution to account for uncertainty about their "true" magnitudes), and the actual data are used as a critical value: if the observed data are greatly at variance with the simulated data, that is taken as evidence against the model and/or its parameter values. This paper reverses the procedure, creating distributions of expected returns by sampling from the estimated projection coefficient distribution and multiplying draws by *ex ante* variable values. These distributions can then be used, e.g., by tabulating the draws, to assess the likelihood that any constraint is satisfied.

One-, three-, six-, and twelve-month holding period returns on maturities from one month out to five years are analyzed, in contrast to most of the literature, which limits analysis to one-month holding periods on bills. Longer maturities are included because evidence shows that observed returns often decline beyond the 1-year maturity (e.g., Fama

[3] Several references are discussed in section III.
[4] For example, Gregory and Smith (1991) and Canova (1994).

1984), and longer holding periods because Amihud and Mendelson (e.g., 1986) and Fisher (1994) have argued that transactions costs have significant impacts on asset pricing relationships, which are exacerbated with short holding periods. The *ex ante* variables are a volatility measure, the level of interest rates, and the slope of the yield curve.

The likelihood of expected returns monotonically increasing in maturity is found to vary systematically across values of the *ex ante* variables and across holding periods. Monotonicity is associated with a steep yield curve and high interest rates. The correlation between nonmonotonic (hump-shaped) maturity-return profiles and the onset of recessions noted by Fama (1986), Fama and Bliss (1987), and Stambaugh (1988) does not receive much support, while a strong tendency toward monotonicity with longer holding periods does.

The paper is organized as follows. Section II describes the data. Section III discusses the existing literature comparing time-varying returns across maturity, computes projections to generate expected return distributions, and performs simulations allowing for time variation in expected returns. Section IV concludes.

II. Data

The data employed are McCulloch's (1990) yield curve estimates updated to early 1991 by McCulloch and Kwon (1993). The principal benefit from using this data source is its wide and even coverage; monthly yields from 1953 through 1990 on maturities from one to sixty months, with no missing values, are analyzed.[5] Previous analysis using CRSP data lose several months to missing observations and have some controversial timing definitions as well.[6] An additional benefit is that the spline-smoothing procedure employed in the construction of the data may reduce measurement error and anomalous

[5] The availiable yield curves are monthly, 1947:01-1991:02; the data before the end of the Fed-Treasury Accord are omitted from the analysis.

[6] E.g., the "Fama (1984) files" define the twelve-month bill as the longest bill with more than eleven months and ten days to maturity; Richardson, Richardson and Smith (1992) considered this definition too unreliable and omitted twelve-month bills from their analysis.

bid/ask spreads that have sometimes occurred and been the source of inference issues (cf. McCulloch 1987). The drawback, of course, is that the observations are not on actually traded securities.

The data are given as continuously compounded yields to maturity on pure discount bonds, observed at monthly intervals, and expressed as annual percentage rates. Denoting such a yield on an n-month bond in period t as $y_n(t)$, its price if the bond pays \$1 at maturity is obtained as

$$pr_n(t) = \exp\{1 - [1 + y_n(t)/100]^{n/12}\}. \quad (1)$$

Holding period returns are associated with the maturity of the bond at the time of purchase: $H_n^{\tau}(t) = \ln[pr_{n-\tau}(t+\tau)] - \ln[pr_n(t)]$ gives the continuously compounded τ-month holding period return on an n-month bond purchased in month t. The return premium (synonomously referred to as the term premium and excess return) is defined as $P_n^{\tau}(t) \equiv H_n^{\tau}(t) - H_{\tau}^{\tau}(t)$. One-, three-, six-, and twelve-month holding periods are analyzed. Return premia may be computed at maturities of two through 18 months for one-month returns; four through 18 plus 21 and 24 months for three-month returns; seven through 18 plus 21, 24, 30, and 36 months for six-month returns; and 13 through 18 plus 21, 24, 30, 36, 48, and 60 months for 12-month returns. The term structures represent the afternoon of the last business day of the month, so as defined a premium $P_n^{\tau}(t)$ should be orthogonal to period t observables under the null of constant term premia.[7]

Tables 1 through 4 report the average term premia for holding periods of one, three, six, and twelve months respectively, for six different sample periods—1/53-7/64, 8/64-12/72, 1/73-12/82, 1/83-2/91, 8/64-12/82, and 1/53-2/91—which comprise those used in Fama (1984), and subsequent papers discussed below. Data from before 1964 have not been used in most recent studies of the maturity structure of term premia.[8] Standard errors,

[7] There is a potential problem with orthogonality and timing when *ex ante* variables like consumption and output are used, because they are subsequently revised. The *ex ante* variables used here are not subject to revision.

[8] Keim and Stambaugh (1986) is an exception. Fama (1984) also analyzes bond, but not bill, returns beginning in 1953.

corrected for heteroscedasticity and overlapping observations, are used to compute t-statistics.

The one-month, three-month, and six-month premia are on average monotonically increasing in maturity in the full sample. The 1964-72 subsample has "wiggles" in the 6-month to 12-month range, and the 1973-82 subsample is hump-shaped; the returns in the latter case are not significantly different from zero beyond 7 months. The premia in the 1982-91 sample are strongly monotonic[9] and numerically much larger than in the other subsamples. Fama (1984) and Richardson, Richardson and Smith (1992) found similar results with CRSP data and one-month returns. The 12-month average premia are monotonic in all samples; in the pre-1982 case they are numerically small and not significantly different from zero, while in the 1982-91 subsample they are again large and significant. If expected returns were constant across time, such differences across subsamples and holding periods would have to be explained by sampling error. Time-varying expected returns provide an alternative or supplemental explanation, which is explored in the next section.

III. The Maturity-Return Structure with Time-Varying Expected Returns

In recent years, a great deal of research in finance has attempted to identify a small number of state variables which proxy for the risks investors are paid to bear. These variables, and thus the underlying risks, are time-varying. Although this research program is far from settled, considerable evidence has been accumulating that returns on default-free bonds and other financial assets are predictable using *ex ante* values of several key variables. These variables include forward rates, variances and conditional variances of returns, spreads between risky and riskless short-term interest rates, measures of the slope of the yield curve, and the level of interest rates or other asset prices.

---

[9] Hereafter, "monotonic" is used to mean "monotonically increasing in maturity."

There are a variety of theoretical reasons for these variables' predictive content. Term structure models like that of Cox, Ingersoll and Ross (1985) imply that forward premiums are predictors of excess returns. Variances are meant to capture risk directly, as they are often interpreted as reflecting fundamental uncertainty about asset returns and about the state of the economy more generally. However, as illustrated in Backus and Gregory (1993), theory generally does not restrict the sign of the conditional second moment-risk premium relationship. Spreads are meant primarily to capture real returns to bearing risk, which may fluctuate with the availability of credit as stressed in the "credit channel of monetary policy" literature.

The slope of the yield curve has been shown to be a powerful forecaster of both real activity and asset returns, although causal interpretations have been varied and controversial. Finally, two conflicting theories of the effects of the level of interest rates on the maturity structure of returns have been advanced. Kessel (1965) argued that since nominal interest rates determine the opportunity cost of holding money balances, the monetary services yielded by short-term bonds are more valuable, the higher the interest rate. Thus, when interest rates are high, long-term bondholders must earn higher average returns to offset these advantages. Nelson (1972), however, argued that term premiums should vary inversely with the level of interest rates owing to the skewed distribution of bond price changes induced by the lower bound of zero on nominal interest rates.

If return premia are partly predictable from linear projections on a vector of *ex ante* observable variables X, then we may write

$$P_n^\tau(t) = X(t)*\beta_n^\tau + \varepsilon_n^\tau(t), \tag{2}$$

and the LPH inequalities, $P_n^\tau > P_{n-j}^\tau \ \forall j > 0$, are a function of both the elements of X and of the β's. While I am not aware of any research that formally tests the LPH with time-varying returns, in recent years several papers have compared estimates of β's for a variety of n and predicted values from (2) for small numbers of maturities. These are discussed in the next subsection.

A. Existing Evidence

Fama (1986) analyzed the two-month holding period return on a three-month bill, the three-month return on a six-month bill, and the six-month return on a 12-month bill (all premia over one-month returns), using Salomon Brothers' *Analytical Record of Yields and Yield Spreads* data running from 1967 to 1985. Regressions of these term premia on the corresponding forward premia yielded coefficients which were significantly different from zero with R^2 values between 0.23 and 0.46, providing strong evidence of time-varying expected returns.

Fama also argued that whether or not the expected term premia were monotonically increasing in maturity was closely related to the stage of the business cycle. Denoting by *Bx/Sy* the return from buying an *x*-month bill and selling it as a *y*-month bill, for each month in November 1971-November 1972, March 1975-March 1978, and July 1983-July 1984, periods that correspond roughly to recoveries and expansions, the ordering of predicted values from the regressions was B1/S0 < B3/S1 < B6/S3 < B12/S6 (monotonic). In the months December 1972-February 1975 and April 1978-June 1983, which correspond to recessions and some months preceeding them, the ordering was B1/S0 < B3/S1 < B6/S3 > B12/S6 (hump-shaped).

Fama and Bliss (1987) analyzed longer holding periods on longer maturity U.S. government bonds, namely one-year excess returns on two- through five-year bonds. Like Fama (1986), they found that regressions of term premia on the corresponding forward premia yielded significant coefficients, although with somewhat lower R^2 values (between 0.05 and 0.14). Since the coefficients were again near 1.0, they equate forward premia with expected return premia, which tend to be positive during expansions and negative before and during recessions. However, Fama and Bliss only informally compared term premia across the different maturity bonds. Stambaugh (1988) extracted latent factors from forward rates and used them to predict return premia. His Figure 3 (p. 65) plots point estimates for expected values of P_{12} - P_6 and P_6 - P_2 (one-month holding period) from

1964 through 1986. While he argued that hump-shaped maturity-return profiles—$P_{12} < P_6 > P_2$—obtain primarily when the economy is heading into a recession, the figure shows that during most of 1964-69, 71-74, and 76-80 that shape is predicted as well. The shape $P_2 < P_6 < P_{12}$ obtains only for a few months, some of which are during expansions and some during recessions.

Keim and Stambaugh (1986) predicted returns using three *ex ante* variables designed to roughly reflect levels of asset prices: the spread between low-grade corporate bonds and one-month Treasury bills, the log of the ratio of the real S&P Composite Index to its average value over the previous 45 years, and the log of the share price, averaged equally across the quintile of smallest market value on the NYSE. They regressed returns on ten bond portfolios, ranging from 6 months' to 20 years' maturity, on each of the *ex ante* variables separately. In each of the three sets of regressions, the coefficients on the regressor are nearly monotonically increasing in maturity, with a supplementary regression suggesting that they are reliably so.

In the regressions on the spread and on the S&P variable, the constant terms are monotonically *decreasing* in maturity, while those in the regressions on the smallest quintile variable are monotonically increasing in maturity. The spread variable is always positive, so the constant and regressor have opposing effects on term premia. When the spread is in its range observed over 1950-80, the predicted return structures can be upward sloping, flat, humped, or downward sloping. The intercept and regressor effects from the S&P equations reinforce each other to predict returns decreasing in maturity when the variable is above its historical average level (it is entered negatively). The constant and the regressor in the smallest quintile regressions have opposite effects when the variable is negative, and like effects, both predicting an increasing return structure, when it is positive. The adjusted R^2 values for the regressions are relatively low (ranging from a high of 0.045 to under 0.01), reflecting the high volatility of longer-term bond returns, and suggesting that many different return-maturity hypotheses might not be rejected by the data.

Campbell (1987) analyzed the ability of four *ex ante* variables—the one-month bill rate, the two-month less the one-month bill rate, the six-month less the one-month bill rate, and a lagged excess return—to predict excess one-month returns on two-month bills, six-month bills, and ten-year bonds in multivariate regressions. The estimated coefficients on the constant, the second yield curve slope, and the lagged excess return are monotonically decreasing, increasing, and increasing in maturity; many of them are significantly different from zero. Thus a variety of shapes for the maturity-return profile are possible. The R^2 values for the regressions range from 0.032 to 0.252. Engle, Ng and Rothschild (1990) ran the full Treasury bill range (one-month excess returns) on these same *ex ante* variables, and found similar results: the constant terms are nearly monotonically decreasing and the coefficients on the level of interest rates are monotonically increasing in maturity. However, the coefficients on the two yield curve slope variables are negative and decreasing, and positive and increasing in maturity, respectively, suggesting that the shape of expected returns may depend upon somewhat subtle changes in the shape of the yield curve.

Engle, Ng, and Rothschild (1990) and Engle and Ng (1993) estimated a one-factor model for T-bill one-month excess returns where the factor is given by an equally weighted bill portfolio with changing excess return variance. They too found that the constant terms in the excess return equations are decreasing in maturity (beyond 5 months), and that the factor betas are increasing in maturity. This has the implication that expected term premia will be increasing in maturity when volatility levels are high, but hump-shaped when volatility is average or low . They also found that the magnitudes of the term premia are quite small unless volatility levels are high, and that factors other than the conditional variance of the weighted bill portfolio also contribute to expected term premia. (Three of Campbell's *ex ante* variables enter significantly in the factor-excess return equations.)

Finally, Klemkosky and Pilotte (1992) examined the predictability of one-month excess returns on two-month bills through twenty-year bonds over 1959-89. They used two *ex ante* variables, the change in the risk-free rate over the holding period, instrumented by the standard deviation of forward rates for the different maturities at *t*, and the level of interest rates. They found that the coefficients on the former variable increase in maturity and, at least for data before 1979, the coefficients on the level of interest rates decrease in maturity. They did not examine the implications for monotonicity or report R^2 values.

These results from the time-varying returns literature are much less supportive of the LPH than are those in the constant returns literature, e.g. McCulloch (1987) or Richardson, Richardson and Smith (1992). In particular, many of the studies find values or combinations of *ex ante* variables which are associated with hump-shaped or downward sloping maturity structures, and several suggest that whether or not returns are monotonic may be a function of the state of the business cycle. In the next subsection, realized return premia from a wide range of sample periods, holding periods, and maturities in the McCulloch data are regressed on three *ex ante* variables, and the results compared with those above. Simulations of time-varying return premia are then generated from these regressions, and used to assess the shape of the expected return-maturity profile under various conditions.

B. Return Premia Regressions

The *ex ante* variables used to predict excess returns throughout the analysis are a measure of volatility (the simple standard deviation of the 1-month yield scaled by its mean over the past 12 months), the yield on a 3-month Treasury bill, and the slope of the yield curve (defined as the 6-month T-bill yield less the 3-month T-bill yield) in month *t*. This unconditional measure of volatility, rather than a conditional one, was used because it involves no out-of-sample information and for its ease of computation. The adjusted R^2 values are as high or higher than those reported in the papers discussed above, so it appears that these variables are capturing most of the information available for predicting return premia.

Tables 5 through 8 present coefficient estimates and *t*-statistics for the regressions of different holding return premia on the *ex ante* variables.[10] Virtually all of the subsamples and holding periods generate similar patterns of coefficients across maturity: the constant terms are usually negative and decreasing in maturity, often significantly so and particularly with longer holding periods. The coefficients on the volatility variable are also mostly negative and monotonically decreasing; they are significantly negative in about one-fourth of the cases. The 3-month bill yield enters with positive, monotonically increasing coefficients which are strongly significant in the majority of cases. Finally, the coefficients on the slope of the yield curve are positive and monotonic, and significantly so in most cases. While the magnitudes differ across holding periods and subsamples, sometimes substantially, coefficients that do not fit these patterns are never statistically different from zero.

Perhaps the most surprising regression results are the negative coefficients on the volatility variable. However, this is due to the scaling of the variable by its mean over the past year: both univariate and multivariate regressions with unscaled (and still unconditional) volatility measure yielded positive coefficients. Though the standard deviation is scaled by the interest rate level, this does not lead to much multicollinearity; the highest pairwise correlation with another *ex ante* variable in any subsample is about 0.40.

The regressions indicate that high interest rates are often significantly associated with return premia *increasing* in maturity. This is consistent with evidence found by Kessel (1965), Pesando (1975), Friedman (1979), McCulloch (1975), and Fama (1976), and supports Kessel's opportunity-cost-of-money argument. It is contradictory to evidence presented by Nelson (1972), Van Horne (1978), and Klemkosky and Pilotte (1992). An association between high interest rates and a monotonic return-maturity profile also does not fit the recession-timing observations of Fama, Bliss, and Stambaugh: interest rates are

---

[10] Only a representative few of the equations are shown, to save space; the full tables are available on request. *t*-statistics use standard errors corrected for heteroscedasticity and overlapping observations.

typically high before and during the early parts of recessions, when they argue that expected returns are hump-shaped.

The finding that coefficients on the slope of the yield curve are monotonically increasing and significant is consistent with much of the evidence discussed above. It is well-known that the yield curve is often inverted before and during recessions, and indeed this variable is near zero or negative and the term structure of returns is downward sloping (beyond a few months) in several recession periods, including early 1956, early 1970, early 1974, and most of 1981. However, there are several expansion months when this variable was well below its mean and thus contributing to expectations of nonmonotonic returns: in late 1962, mid 1964 (when both volatility and the level of interest rates were very low), and 1968.

While the coefficients vary across subsamples, χ^2 tests for whether the coefficients differ statistically between the full sample and any subsample do not reject at anywhere near conventional significance levels. Therefore, the coefficients from the full-sample estimation are used in all of the simulation work in described in the next subsection.

C. Monte Carlo Evidence on Monotonicity with Time-Varying Returns

Time-varying expected return premia are generated with predicted values from (2), in stacked vectors of multiple observations and maturities:

$$\hat{P} = (I_N \otimes X)\hat{\beta}, \tag{3}$$

where $\hat{P}$ is a TxN vector of return premia, X is a matrix of T observations on the three *ex ante* variables plus a constant, and $\hat{\beta}$ is the vector of estimated coefficients (reported in Tables 5A-8A), e.g., for one-month holding periods $\hat{\beta} = [\hat{\beta}_2^1\ \hat{\beta}_3^1\ \ldots\ \hat{\beta}_N^1]'$. $\hat{\beta}$ is assumed to be normally distributed around its point estimate with its estimated asymptotic variance-covariance matrix,[11] and X is treated as fixed in the simulations.

[11] There is evidence that returns, and so expected returns, are fatter-tailed than Normal. This is partly accounted for by adjusting the variance-covariance matrix of $\hat{\beta}$ for heteroscedasticity.

Since each observation has different values of the *ex ante* variables which lead to different expected return premia and maturity-return patterns, it is generally not appropriate to compute averages across observations within a subsample. Instead, simulations are conducted with the *ex ante* variables set at particular values to assess the likelihood of different maturity-return profiles when the economy is in those representative states. Draws are smoothed[12] and then categorized as either monotonically increasing, hump-shaped, or neither, with the definition for the second being if any one of the "internal" average premiums exceeds both endpoints, e.g., P_5 greater than both P_2 and P_{18} in the one-month case.

The first set of simulations measures the preponderance of monotonic and hump-shaped maturity-return profiles at a variety of combinations of the *ex ante* variables. Each is set equal to its mean, its 20th percentile observed value, and its 80th percentile value, giving 27 different combinations for each holding period. In each of these 27 x 4 cases, 1000 draws were taken. The results are tabulated in Tables 9-12.

The frequency with which expected return premia display a monotonic or hump-shaped pattern is seen to be closely tied to the values of the *ex ante* variables. Monotonicity is associated primarily with a steep yield curve, and to a lesser degree with high interest rate levels. These are the main factors which distinguish the 1980s subsample, with its very strong *ex post* monotonic character (cf. Tables 1-4), from the other subsamples. Longer holding periods also favor monotonicity. Hump-shaped maturity-return profiles are associated primarily with flat or inverted yield curves, and the level of (scaled) volatility plays a minor role. The results with twelve-month holding periods are stark—there are many 0% and 100% entries. This is primarily caused by the much smaller variance of the expected returns, which is illustrated by the narrow confidence intervals shown in Figure 4 and discussed below.

---

12 Draws are smoothed with a moving average filter to eliminate "blips" in the maturity profile. The weights are (1/9 2/9 3/9 2/9 1/9) on (P_{n-2} P_{n-1} P_n P_{n+1} P_{n+2}) for "interior" n, (1/2 1/3 1/6) on the first three premiums (symmetric for the last three), and (1/4 3/8 1/4 1/8) on the first four premiums (again symmetric on the last four).

The second set of simulations essentially puts confidence intervals on point estimates of expected return premia for a few selected maturities like those plotted in Stambaugh's (1988) Figure 3. One thousand draws of expected premia were taken, using the full set of T observations, for the shortest, the longest, and one-half the longest available maturity for each holding period: $\{P_2^1, P_9^1, P_{18}^1\}$; $\{P_4^3, P_{12}^3, P_{24}^3\}$, $\{P_7^6, P_{18}^6, P_{36}^6\}$, and $\{P_{13}^{12}, P_{30}^{12}, P_{60}^{12}\}$. The draws were then sorted, and the 5th and 95th percentiles plotted in Figures 1-4.

In all cases, expected premia at the shortest maturity are small, usually positive, and relatively certain—the 5th and 95th percentiles nearly coincide. In the one-month, three-month, and six-month holding period cases, the greater uncertainty at longer maturities is evident, with the 90% confidence interval for the longest maturity bracketing the other two in 30-40% of the data observations. The confidence intervals also all show positively sloped trends: a salient feature with all four holding periods is that expected returns have gotten larger and more monotonic over time, at least up through the early 1980s.

The association between monotonic and hump-shaped patterns and the business cycle that Fama, Bliss, and Stambaugh have described—with the former obtaining in periods of expansion and the latter before or during recessions—has many exceptions. For example, with the three- and six-month holding periods, the confidence interval bands for these maturities are strictly monotonic (do not intersect) in only three of these months in the twelve years up to August 1966; and during the long expansion of the 1980s, the only months displaying strict monotonicity are in 1984 and 1987, during times of slowing growth. Conversely, the bands are strictly monotonic in several of the months just preceding the recession of 1969-70 and during the recessions of 1974-75 and 1981-82.

The results for the 12-month holding period are similar, differing primarily in that the confidence interval bands are much tighter. Here about two-thirds of the months display strict monotonicity. Again the correlation with the business cycle appears weak. Many of the expansion months in the years up to 1966 have a nonmonotonic pattern, and many of the months in the recessions of 1974-75 and 1980-82 recessions are monotonic.

The final set of simulations addresses the business cycle correlation more directly. Here draws are taken using observations that are within 6 months of a business cycle peak (e.g. February 1990 through January 1991), and the percentage of the 1000 x 13 months that are monotonic and hump-shaped are tabulated. The percentages are 24.0%, 34.1%, 49.8%, and 75.6% monotonic (ordered with holding period increasing), while 46.3%, 36.4%, 25.0%, and 13.4% were hump-shaped. The largest percentage of hump-shaped is in the one-month case, and again, holding period seems to be the dominant factor. The strong influence of holding period may reflect the importance of transactions costs, as argued by Amihud and Mendelson (1986), McCulloch (1987), and Fisher (1994), which suggests that the longer holding period cases—which favor monotonicity most of the time—should be given the greatest weight.

V. Summary and Conclusions

This paper has analyzed the maturity structure of term premia using McCulloch's U.S. Treasury yield curve data, simulating the distribution of time-varying expected returns from projections of observed returns on three *ex ante* predictor variables: interest rate volatility (scaled by the level of the interest rate), the level of interest rates, and the slope of the yield curve. The simulation methodology allows econometrically nonstandard hypotheses like the multiple inequality constraints of the LPH to be evaluated.

The likelihood of expected returns monotonically increasing in maturity, as implied by the LPH, is found to vary systematically across values of the *ex ante* variables, and thus across time. Monotonicity is associated primarily with a steep yield curve and high interest rates, and to a lesser degree with low levels of volatility. Hump-shaped patterns are associated with various other combinations, which sometimes occur near business cycle peaks, although the finding of Fama, Bliss, and Stambaugh that nonmonotonic (hump-shaped) maturity-return profiles are correlated with the onset of recessions is not a robust pattern. Monotonicity is also strongly associated with longer holding periods, prevailing in most periods with twelve-month holding periods. To the extent that transactions costs play a smaller role the longer the holding period, this may be interpreted as evidence that gross expected returns are monotonic for most values of *ex ante* variables.

References

Amihud, Y., and H. Mendelson, 1986, "Asset Pricing and the Bid-Ask Spread," *Journal of Financial Economics* 17, 223-49.

Backus, D.K., and A.W. Gregory, 1993, "Theoretical Relations Between Risk Premiums and Conditional Variances," *Journal of Business and Economic Statistics* 11, 177-85.

Breeden, D., 1986, "Consumption, Production, Inflation, and Interest Rates: A synthesis," *Journal of Financial Economics* 16, 3-39.

Campbell, John Y., 1987, "Stock Returns and the Term Structure," *Journal of Financial Economics*18, 373-99.

Canova, F., 1994, "Statistical Inference in Calibrated Models," *Journal of Applied Econometrics*9, S123-44.

Cox, J.C., J.E. Ingersoll, and S.A. Ross, 1985, A Theory of the Term Structure of Interest Rates, *Econometrica* 53, 385-407.

Engle, R.F., and V.K. Ng, 1993, "Time-Varying Volatility and the Dynamic Behavior of the Term Structure," *Journal of Money, Credit, and Banking* 25, 336-49.

Engle, R.F., V.K. Ng, and M. Rothschild, 1990 "Asset Pricing with a Factor ARCH Covariance Structure: Empirical Estimates for Treasury Bills," *Journal of Econometrics* 45, 213-37.

Fama, E.F., 1976, "Inflation Uncertainty and Expected Returns on Treasury Bills," *Journal of Political Economy* 84, 427-48.

________, 1984, "Term Premiums in Bond Returns," *Journal of Financial Economics* 13, 529-46.

________, 1986, "Term Premiums and Default Premiums in Money Markets," *Journal of Financial Economics* 17, 175-96.

________, 1990, "Term-Structure Forecasts of Interest Rates, Inflation, and Real Returns," *Journal of Monetary Economics* 25, 59-76.

Fama, E.F, and R.R. Bliss, 1987, "The Information in Long-Maturity Forward Rates," *American Economic Review* 77, 680-92.

Fisher, S.J., 1994, "Asset Trading, Transaction Costs and the Equity Premium," *Journal of Applied Econometrics* 9, S71-94.

Friedman, B., 1979, "Interest Rate Expectations versus Forward Rates: Evidence from an Expectations Survey," *Journal of Finance* 34, 965-73.

Gregory, A.W., and G.W. Smith, 1991, "Calibration as Testing: Inference in Simulated Macroeconomic Models," *Journal of Business and Economic Statistics* 9, 297-304.

Hicks, J. R., 1946, *Value and Capital, 2nd ed.*, London: Oxford University Press.

Hooker, M.A., and M. Kohn, 1995, "An Empirical Measure of Asset Liquidity," Dartmouth College Working Paper.

Ibbotsen Associates, 1994, *Stocks, Bonds, Bills, and Inflation: 1994 Yearbook* (Ibbotsen Associates, Chicago, IL).

Kayshap, A.K., J.C. Stein, and D.W. Wilcox, 1993, "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance," *American Economic Review* 83, 78-98.

Keim, D.B. and R.F. Stambaugh, 1986, "Predicting Returns in the Stock and Bond Markets," *Journal of Financial Economics* 17, 357-90.

Kessel, R., 1965, "The Cyclical Behavior of the Term Structure of Interest Rates," NBER Occasional Paper no. 91.

Keynes, J.M. (1930), *A Treatise on Money*, Vol. 2. London.

Klemkosky, R.C. and E.A. Pilotte, 1992, "Time-Varying Term Premia on U.S. Treasury Bills and Bonds," *Journal of Monetary Economics* 30, 87-106.

Lauterbach, B., 1989, "Consumption volatility, production volatility, spot-rate volatility, and the returns on treasury bills and bonds," *Journal of Financial Economics* 24, 155-79.

Lippman, S.A. and J.J. McCall (1986), An Operational Measure of Liquidity, *American Economic Review* 76, 43-55.

McCulloch, J.H., 1975, "An Estimate of the Term Premium," *Journal of Political Economy* 83, 95-119.

________, 1987, "The Monotonicity of the Term Premium: A Closer Look," *Journal of Financial Economics* 18, 185-92.

________, 1990, "The Term Structure of Interest Rates: Appendix," in B. Friedman and F. Hahn, eds., *Handbook of Monetary Economics*, North Holland.

McCulloch, J.H. and H-C. Kwon, 1993, "U.S. Term Structure Data, 1947-1991," Ohio State University Working Paper #93-6.

Nelson, C.R., 1972, *The Term Structure of Interest Rates* (Basic Books, New York, NY).

Pesando, J., 1975, "Determinants of Term Premiums in the Market for United States Treasury Bills," *Journal of Finance* XXX, 1317-27.

Rubenstein, M., 1974, "An Aggregation Theorem for Securities Markets," *Journal of Financial Economics* 1, 225-44.

Richardson, M., Richardson, P., and T. Smith, 1992, "The Monotonicity of the Term Premium: Another Look," *Journal of Financial Economics* 31, 97-105.

Stambaugh, R.F., 1988, "The Information in Forward Rates: Implications for Models of the Term Structure," *Journal of Financial Economics* 21, 41-70.

Van Horne, J., 1978, *Financial Market Rates and Flows* (Prentice-Hall, Englewood Cliffs, NJ).

Table 1: Average 1-month return premia

	53:01-91:01	53:01-64:07	64:08-72:12	73:01-82:12	83:01-91:01	64:08-82:12
P_2	.400 (14.00)	.283 (9.28)	.337 (9.15)	.423 (4.83)	.584 (9.73)	.408 (7.99)
P_3	.609 (11.20)	.441 (8.08)	.457 (6.61)	.625 (3.64)	.946 (8.48)	.625 (6.20)
P_4	.764 (9.50)	.545 (6.96)	.624 (6.09)	.761 (2.95)	1.178 (7.16)	.827 (5.51)
P_5	.907 (8.52)	.609 (6.05)	.811 (5.92)	.898 (2.59)	1.384 (6.54)	1.019 (5.12)
P_6	1.001 (7.49)	.650 (5.32)	.879 (4.99)	.981 (2.21)	1.584 (6.22)	1.113 (4.44)
P_7	1.055 (6.51)	.682 (4.76)	.859 (3.91)	.970 (1.78)	1.798 (6.03)	1.125 (3.69)
P_8	1.094 (5.75)	.706 (4.30)	.825 (3.12)	.898 (1.40)	2.032 (5.91)	1.109 (3.09)
P_9	1.137 (5.22)	.728 (3.92)	.804 (2.60)	.812 (1.11)	2.291 (5.85)	1.101 (2.68)
P_{10}	1.192 (4.88)	.749 (3.62)	.802 (2.27)	.730 (0.89)	2.577 (5.86)	1.108 (2.41)
P_{11}	1.252 (4.64)	.770 (3.38)	.813 (2.05)	.663 (0.74)	2.856 (5.87)	1.124 (2.22)
P_{12}	1.317 (4.47)	.792 (3.18)	.832 (1.90)	.626 (0.64)	3.123 (5.86)	1.153 (2.09)
P_{13}	1.386 (4.34)	.812 (3.01)	.858 (1.78)	.612 (0.58)	3.372 (5.82)	1.191 (2.01)
P_{14}	1.450 (4.22)	.831 (2.87)	.888 (1.70)	.605 (0.54)	3.596 (5.75)	1.228 (1.93)
P_{15}	1.508 (4.10)	.848 (2.74)	.922 (1.63)	.603 (0.50)	3.787 (5.65)	1.264 (1.86)
P_{16}	1.561 (3.98)	.869 (2.64)	.955 (1.57)	.601 (0.47)	3.954 (5.52)	1.296 (1.79)
P_{17}	1.605 (3.85)	.886 (2.54)	.982 (1.51)	.595 (0.44)	4.101 (5.36)	1.324 (1.72)
P_{18}	1.684 (3.73)	.904 (2.45)	1.012 (1.46)	.586 (0.41)	4.240 (5.21)	1.354 (1.66)

t-statistics, corrected for heteroscedasticity, in parentheses. Average returns multiplied by 1200, so the units are percent per year.

Table 2: Average 3-month return premia

	53:01-90:11	53:01-64:07	64:08-72:12	73:01-82:12	83:01-90:11	64:08-82:12
P_4	.256 (9.86)	.182 (7.01)	.208 (6.37)	.255 (3.44)	.396 (6.52)	.276 (5.88)
P_5	.425 (8.15)	.292 (5.72)	.365 (5.63)	.419 (2.71)	.662 (5.51)	.480 (5.00)
P_6	.556 (7.15)	.362 (4.80)	.503 (5.18)	.543 (2.28)	.873 (5.12)	.643 (4.48)
P_7	.653 (6.39)	.407 (4.11)	.577 (4.40)	.616 (1.93)	1.081 (5.05)	.742 (3.94)
P_8	.715 (5.64)	.440 (3.59)	.578 (3.42)	.619 (1.56)	1.298 (5.04)	.773 (3.31)
P_9	.759 (5.00)	.466 (3.20)	.548 (2.61)	.569 (1.21)	1.533 (5.00)	.769 (2.76)
P_{10}	.805 (4.53)	.488 (2.92)	.525 (2.08)	.497 (0.91)	1.790 (4.97)	.766 (2.35)
P_{11}	.857 (4.21)	.510 (2.70)	.517 (1.76)	.428 (0.69)	2.062 (4.96)	.773 (2.08)
P_{12}	.917 (4.00)	.531 (2.53)	.523 (1.56)	.374 (0.55)	2.338 (4.95)	.793 (1.90)
P_{13}	.981 (3.87)	.551 (2.40)	.538 (1.44)	.341 (0.45)	2.603 (4.95)	.824 (1.79)
P_{14}	1.047 (3.78)	.571 (2.29)	.560 (1.36)	.327 (0.40)	2.851 (4.95)	.860 (1.72)
P_{15}	1.110 (3.70)	.590 (2.20)	.587 (1.30)	.322 (0.37)	3.076 (4.93)	.899 (1.66)
P_{16}	1.169 (3.63)	.609 (2.12)	.617 (1.27)	.320 (0.34)	3.273 (4.89)	.934 (1.62)
P_{17}	1.221 (3.56)	.627 (2.06)	.646 (1.23)	.318 (0.32)	3.446 (4.83)	.967 (1.58)
P_{18}	1.268 (3.48)	.645 (2.00)	.675 (1.21)	.312 (0.29)	3.602 (4.74)	.997 (1.54)
P_{21}	1.389 (3.25)	.697 (1.87)	.746 (1.12)	.269 (0.22)	4.024 (4.40)	1.084 (1.43)
P_{24}	1.506 (3.06)	.747 (1.77)	.791 (1.03)	.196 (0.14)	4.489 (4.13)	1.172 (1.35)

t-statistics, corrected for heteroscedasticity and overlapping data observations, in parentheses. Average returns multiplied by 400, so the units are percent per year.

Table 3: Average 6-month return premia

	53:01-90:08	53:01-64:07	64:08-72:12	73:01-82:12	83:01-90:08	64:08-82:12
P_7	.176	.114	.140	.175	.294	.188
	(7.48)	(4.35)	(4.27)	(2.92)	(5.44)	(4.61)
P_8	.291	.185	.218	.269	.527	.306
	(6.23)	(3.62)	(3.33)	(2.24)	(4.86)	(3.73)
P_9	.379	.234	.270	.314	.744	.386
	(5.47)	(3.10)	(2.74)	(1.78)	(4.61)	(3.18)
P_{10}	.449	.269	.293	.321	.974	.434
	(4.89)	(2.70)	(2.21)	(1.40)	(4.55)	(2.72)
P_{11}	.505	.296	.286	.294	1.217	.453
	(4.37)	(2.41)	(1.69)	(1.04)	(4.54)	(2.27)
P_{12}	.557	.320	.272	.249	1.471	.462
	(3.96)	(2.19)	(1.31)	(0.74)	(4.51)	(1.91)
P_{13}	.611	.342	.266	.204	1.729	.477
	(3.68)	(2.04)	(1.09)	(0.52)	(4.48)	(1.67)
P_{14}	.670	.363	.272	.170	1.986	.501
	(3.50)	(1.92)	(0.96)	(0.38)	(4.46)	(1.53)
P_{15}	.731	.384	.287	.147	2.233	.532
	(3.39)	(1.82)	(0.89)	(0.29)	(4.44)	(1.45)
P_{16}	.792	.404	.308	.135	2.463	.568
	(3.33)	(1.75)	(0.86)	(0.24)	(4.43)	(1.40)
P_{17}	.851	.424	.333	.131	2.672	.604
	(3.28)	(1.69)	(0.85)	(0.22)	(4.40)	(1.38)
P_{18}	.906	.444	.361	.129	2.861	.640
	(3.25)	(1.65)	(0.85)	(0.20)	(4.35)	(1.36)
P_{21}	1.046	.501	.442	.107	3.335	.734
	(3.11)	(1.55)	(0.84)	(0.14)	(4.12)	(1.31)
P_{24}	1.165	.555	.503	.054	3.775	.820
	(2.95)	(1.48)	(0.80)	(0.06)	(3.84)	(1.25)
P_{30}	1.450	.658	.556	-.048	4.930	1.007
	(2.78)	(1.40)	(0.68)	(-0.04)	(3.63)	(1.16)
P_{36}	1.784	.748	.553	-.085	6.306	1.185
	(2.75)	(1.33)	(0.56)	(-0.06)	(3.70)	(1.11)

t-statistics, corrected for heteroscedasticity and overlapping data observations, in parentheses. Average returns multiplied by 200, so the units are percent per year.

Table 4: Average 12-month return premia

	53:01-90:02	53:01-64:07	64:08-72:12	73:01-82:12	83:01-90:02	64:08-82:12
P_{13}	.113 (4.75)	.066 (3.26)	.064 (1.85)	.096 (1.82)	.252 (5.41)	.102 (2.62)
P_{14}	.199 (4.12)	.110 (2.82)	.101 (1.46)	.155 (1.42)	.473 (4.94)	.173 (2.18)
P_{15}	.271 (3.75)	.143 (2.48)	.130 (1.24)	.194 (1.19)	.684 (4.71)	.229 (1.93)
P_{16}	.335 (3.48)	.168 (2.21)	.147 (1.04)	.218 (1.02)	.895 (4.61)	.271 (1.73)
P_{17}	.391 (3.24)	.190 (2.00)	.149 (0.84)	.231 (0.87)	1.103 (4.52)	.300 (1.54)
P_{18}	.443 (3.05)	.209 (1.84)	.150 (0.70)	.236 (0.74)	1.305 (4.42)	.323 (1.38)
P_{21}	.596 (2.74)	.264 (1.58)	.186 (0.59)	.252 (0.53)	1.871 (4.10)	.410 (1.18)
P_{24}	.740 (2.62)	.316 (1.46)	.250 (0.61)	.270 (0.45)	2.366 (3.81)	.507 (1.13)
P_{30}	1.004 (2.44)	.418 (1.35)	.349 (0.59)	.283 (0.33)	3.308 (3.47)	.681 (1.05)
P_{36}	1.307 (2.37)	.511 (1.29)	.373 (0.48)	.343 (0.30)	4.462 (3.47)	.856 (0.99)
P_{48}	1.876 (2.24)	.652 (1.17)	.371 (0.34)	.479 (0.28)	6.701 (3.28)	1.179 (0.91)
P_{60}	2.473 (2.12)	.726 (1.03)	.427 (0.31)	.494 (0.21)	9.240 (3.13)	1.506 (0.84)

t-statistics, corrected for heteroscedasticity and overlapping data observations, in parentheses. Average returns multiplied by 100, so the units are percent per year.

Table 5: Excess Return Regressions for 1-month Holding Periods

	Regressors				
	constant	volatility	interest rate	yield slope	R^2
A. Sample 54:01-91:01					
P_2	-.013	.008	.063	.175	.10
	(-0.11)	(0.03)	(3.95)	(0.90)	
P_4	-.211	-.625	.108	1.733	.09
	(-0.63)	(-0.73)	(2.34)	(3.04)	
P_6	-.550	-1.571	.153	3.504	.11
	(-0.96)	(-1.13)	(1.92)	(4.36)	
P_9	-.912	-3.063	.182	5.609	.10
	(-1.00)	(-1.40)	(1.39)	(4.72)	
P_{12}	-1.224	-4.484	.213	7.623	.09
	(-1.05)	(-1.57)	(1.26)	(4.91)	
P_{13}	-1.346	-4.879	.229	8.242	.09
	(-1.08)	(-1.59)	(1.26)	(4.95)	
P_{18}	-1.887	-6.790	.288	11.102	.09
	(-1.09)	(-1.66)	(1.13)	(4.83)	
B. Sample 54:01-64:07					
P_2	-.347	.500	.190	0.137	.19
	(-2.77)	(1.53)	(4.60)	(0.44)	
P_4	-.570	.147	.357	0.771	.13
	(-1.69)	(0.16)	(3.01)	(0.92)	
P_6	-.355	-1.201	.328	1.931	.10
	(-0.66)	(-0.79)	(1.81)	(1.57)	
P_9	.148	-3.303	.238	3.042	.07
	(0.18)	(-1.42)	(0.89)	(1.89)	
P_{12}	.613	-5.132	.164	3.796	.06
	(0.58)	(-1.68)	(0.46)	(1.81)	
P_{18}	1.239	-8.129	.078	5.285	.05
	(0.80)	(-1.87)	(0.14)	(1.72)	

Table 5: Excess Return Regressions for 1-month Holding Periods (cont'd)

C. Sample 64:08-72:12

P_2	-.297	-.180	.141	-0.196	.17
	(-2.00)	(-0.21)	(4.73)	(-0.82)	
P_4	-.508	.456	.228	-0.203	.03
	(-1.08)	(0.16)	(2.46)	(-0.25)	
P_6	-1.355	-.468	.399	1.084	.05
	(-1.66)	(-0.10)	(2.50)	(0.88)	
P_9	-2.570	-1.915	.623	1.705	.03
	(-1.84)	(-0.24)	(2.21)	(0.82)	
P_{12}	-3.528	-2.165	.826	1.691	.02
	(-1.76)	(-0.19)	(2.01)	(0.57)	
P_{18}	-5.528	-2.875	1.231	2.549	.01
	(-1.68)	(-0.15)	(1.84)	(0.53)	

D. Sample 73:01-82:12

P_2	-.405	-1.867	.123	.188	.13
	(-1.05)	(-1.13)	(2.79)	(0.43)	
P_4	-.767	-5.488	.215	1.692	.05
	(-0.67)	(-1.01)	(1.69)	(1.23)	
P_6	-2.757	-7.403	.405	4.850	.10
	(-1.36)	(-0.82)	(1.76)	(2.17)	
P_9	-5.010	-7.875	.531	8.757	.09
	(-1.53)	(-0.51)	(1.37)	(2.54)	
P_{12}	-6.964	-7.736	.621	12.289	.09
	(-1.65)	(-0.37)	(1.24)	(2.72)	
P_{18}	-11.610	-6.442	.912	19.437	.10
	(-1.80)	(-0.21)	(1.19)	(2.77)	

E. Sample 83:01-91:01

P_2	.354	-1.877	.040	.432	.05
	(0.76)	(-2.04)	(0.70)	(1.46)	
P_4	-.944	-3.267	.224	2.527	.27
	(-0.88)	(-1.40)	(1.74)	(3.65)	
P_6	-1.098	-5.287	.269	4.024	.25
	(-0.69)	(-1.35)	(1.41)	(4.36)	
P_9	-1.554	-7.146	.379	5.821	.21
	(-0.67)	(-1.10)	(1.35)	(4.32)	
P_{12}	-2.308	-7.180	.512	7.726	.20
	(-0.79)	(-0.80)	(1.42)	(4.43)	
P_{18}	-2.523	-12.055	.646	10.595	.15
	(-0.58)	(-0.88)	(1.19)	(4.19)	

Selected maturities. t-statistics, corrected for heteroscedasticity, in parentheses. The dependent variable P_τ is the holding period return from buying a τ-month bill at t and selling it as a τ-1 month bill at t+1, less the return on the one-month bill, expressed at annual rates. Volatility is the sample standard deviation of one-month yield from t-12 to t-1 divided by the mean level over those months; interest rate is the month t yield on the three month bill, and the slope of the yield curve is the six-month yield at t less the three month yield at t. R^2 is adjusted.

Table 6: Excess Return Regressions for 3-month Holding Periods

	Regressors				
	constant	volatility	interest rate	yield slope	R^2
A. Sample 54:01-90:11					
P_4	-.079	-.192	.037	0.575	.24
	(-0.87)	(-0.98)	(2.96)	(5.47)	
P_6	-.319	-.952	.088	1.973	.24
	(-1.13)	(-1.55)	(2.24)	(6.92)	
P_9	-.711	-2.304	.147	3.692	.21
	(-1.32)	(-1.95)	(1.95)	(6.63)	
P_{12}	-1.037	-3.897	.184	5.618	.20
	(-1.36)	(-2.25)	(1.72)	(6.39)	
P_{18}	-1.659	-6.322	.275	8.682	.19
	(-1.41)	(-2.42)	(1.63)	(6.23)	
P_{24}	-2.278	-8.524	.337	11.846	.18
	(-1.46)	(-2.44)	(1.49)	(6.04)	
B. Sample 54:01-64:07					
P_4	-.161	-.029	.094	.518	.37
	(-2.01)	(-0.23)	(3.45)	(3.51)	
P_6	-.286	-.694	.195	1.400	.28
	(-1.16)	(-1.47)	(2.34)	(2.89)	
P_9	-.095	-2.370	.218	2.286	.20
	(-0.18)	(-2.33)	(1.30)	(2.32)	
P_{12}	.259	-4.202	.187	3.013	.18
	(0.34)	(-2.67)	(0.76)	(2.00)	
P_{18}	.738	-7.166	.163	4.369	.17
	(0.61)	(-2.92)	(0.42)	(1.79)	
P_{24}	.882	-9.449	.216	5.654	.17
	(0.56)	(-3.05)	(0.42)	(1.78)	

Table 6: Excess Return Regressions for 3-month Holding Periods (cont'd)

C. Sample 64:08-72:12

P_4	-.225	-.159	.078	0.224	.16
	(-2.20)	(-0.23)	(3.64)	(1.22)	
P_6	-.804	-.257	.211	1.053	.17
	(-2.39)	(-0.13)	(3.13)	(2.16)	
P_9	-2.116	-1.092	.443	2.121	.15
	(-2.91)	(-0.24)	(3.13)	(2.10)	
P_{12}	-3.394	-1.599	.668	2.799	.12
	(-3.00)	(-0.22)	(3.04)	(1.69)	
P_{18}	-5.767	-1.359	1.123	3.662	.11
	(-3.08)	(-0.11)	(3.03)	(1.21)	
P_{24}	-8.122	-.572	1.554	4.576	.10
	(-3.09)	(-0.03)	(2.96)	(1.06)	

D. Sample 73:01-82:12

P_4	-.322	-1.790	.074	.707	.22
	(-1.12)	(-1.37)	(2.24)	(2.32)	
P_6	-1.256	-5.498	.217	2.603	.24
	(-1.41)	(-1.20)	(2.06)	(2.94)	
P_9	-3.204	-8.972	.412	5.513	.23
	(-1.88)	(-0.99)	(1.96)	(3.22)	
P_{12}	-4.751	-11.355	.515	8.441	.22
	(-1.98)	(-0.88)	(1.69)	(3.51)	
P_{18}	-8.266	-12.049	.760	13.765	.22
	(-2.22)	(-0.62)	(1.53)	(3.64)	
P_{24}	-10.717	-15.226	.939	18.315	.21
	(-2.20)	(-0.58)	(1.41)	(3.64)	

E. Sample 83:01-90:11

P_4	-.463	-1.150	.104	.567	.46
	(-1.59)	(-1.50)	(2.93)	(4.60)	
P_6	-1.489	-3.228	.274	1.894	.52
	(-1.97)	(-1.59)	(2.94)	(6.50)	
P_9	-2.013	-6.933	.418	3.448	.45
	(-1.61)	(-1.65)	(2.61)	(6.02)	
P_{12}	-3.032	-9.059	.610	5.306	.43
	(-1.69)	(-1.34)	(2.62)	(5.49)	
P_{18}	-3.802	-15.629	.850	8.294	.37
	(-1.35)	(-1.34)	(2.25)	(5.81)	
P_{24}	-5.823	-22.068	1.184	11.657	.35
	(-1.46)	(-1.31)	(2.23)	(5.51)	

Selected maturities. t-statistics, corrected for heteroscedasticity and overlapping data observations, in parentheses. The dependent variable P_τ is the holding period return from buying a τ-month bill at t and selling it as a τ-3 month bill at t+3, less the return on the three-month bill, expressed at annual rates. See table 5 for explanatory variable definitions. R^2 is adjusted.

Table 7: Excess Return Regressions for 6-month Holding Periods

	Regressors				
	constant	volatility	interest rate	yield slope	R^2
A. Sample 54:01-90:08					
P_7	-.078	-.184	.032	.369	.29
	(-1.29)	(-1.06)	(3.46)	(6.01)	
P_9	-.244	-.760	.078	1.073	.24
	(-1.35)	(-1.43)	(2.88)	(5.53)	
P_{12}	-.492	-1.911	.131	2.141	.22
	(-1.38)	(-1.83)	(2.52)	(4.76)	
P_{15}	-.748	-3.091	.184	3.247	.21
	(-1.37)	(-1.96)	(2.33)	(4.44)	
P_{24}	-1.341	-5.934	.308	5.966	.19
	(-1.36)	(-2.09)	(2.14)	(4.44)	
P_{36}	-2.409	-9.127	.488	10.184	.20
	(-1.47)	(-2.01)	(2.08)	(4.45)	
B. Sample 54:01-64:07					
P_7	-.120	-.141	.066	.441	.43
	(-1.84)	(-1.16)	(3.16)	(3.81)	
P_9	-.292	-.678	.167	1.074	.35
	(-1.39)	(-1.75)	(2.52)	(2.79)	
P_{12}	-.312	-1.953	.244	1.770	.30
	(-0.74)	(-2.47)	(1.82)	(2.27)	
P_{15}	-.261	-3.272	.299	2.346	.29
	(-0.43)	(-2.86)	(1.53)	(2.04)	
P_{24}	-.453	-6.203	.523	3.897	.30
	(-0.45)	(-3.46)	(1.53)	(1.79)	
P_{36}	-1.035	-9.350	.879	6.037	.34
	(-0.68)	(-4.02)	(1.66)	(1.93)	

Table 7: Excess Return Regressions for 6-month Holding Periods (cont'd)

C. Sample 64:08-72:12

P_7	-.318	.028	.075	.302	.30
	(-3.28)	(0.04)	(3.62)	(3.35)	
P_9	-.939	.353	.200	.676	.22
	(-3.04)	(0.18)	(2.95)	(2.38)	
P_{12}	-2.116	.935	.400	1.136	.18
	(-3.06)	(0.22)	(2.63)	(1.81)	
P_{15}	-3.266	1.677	.595	1.581	.16
	(-2.96)	(0.26)	(2.43)	(1.53)	
P_{24}	-6.428	3.998	1.158	2.862	.17
	(-2.86)	(0.34)	(2.29)	(1.27)	
P_{36}	-10.070	9.176	1.724	4.223	.15
	(-2.67)	(0.49)	(2.07)	(1.10)	

D. Sample 73:01-82:12

P_7	-.221	-1.443	.059	.368	.24
	(-1.64)	(-1.21)	(3.37)	(2.77)	
P_9	-.592	-4.191	.140	1.079	.19
	(-1.48)	(-1.20)	(2.86)	(2.56)	
P_{12}	-1.214	-7.321	.219	2.237	.16
	(-1.61)	(-1.11)	(2.29)	(2.66)	
P_{15}	-1.901	-10.022	.291	3.484	.15
	(-1.62)	(-1.04)	(1.94)	(2.83)	
P_{24}	-3.672	-13.160	.441	6.513	.13
	(-1.61)	(-0.77)	(1.58)	(3.06)	
P_{36}	-5.208	-21.800	.620	10.347	.14
	(-1.44)	(-0.84)	(1.45)	(3.22)	

E. Sample 83:01-90:08

P_7	-.359	-1.177	.085	.356	.60
	(-1.84)	(-1.80)	(3.44)	(6.80)	
P_9	-1.288	-3.093	.260	1.044	.62
	(-2.51)	(-1.62)	(3.96)	(8.84)	
P_{12}	-2.543	-5.609	.505	2.087	.59
	(-3.03)	(-1.41)	(4.61)	(7.81)	
P_{15}	-3.907	-7.695	.762	3.152	.57
	(-3.20)	(-1.27)	(4.81)	(6.56)	
P_{24}	-7.175	-16.896	1.391	5.947	.49
	(-2.95)	(-1.35)	(4.48)	(5.77)	
P_{36}	-12.101	-22.762	2.237	10.610	.44
	(-2.68)	(-1.02)	(3.99)	(5.74)	

Selected maturities. *t*-statistics, corrected for heteroscedasticity and overlapping data observations, in parentheses. The dependent variable P_τ is the holding period return from buying a τ-month bill at t and selling it as a τ-6 month bill at t+6, less the return on the six-month bill, expressed as annual rates. See table 5 for explanatory variable definitions. R^2 is adjusted.

Table 8: Excess Return Regressions for 12-month Holding Periods

	Regressors				
	constant	volatility	interest rate	yield slope	R^2
A. Sample 54:01-90:01					
P_{13}	-.064	-.081	.024	.182	.28
	(-1.18)	(-0.75)	(2.95)	(3.14)	
P_{15}	-.218	-.332	.067	.562	.25
	(-1.33)	(-1.02)	(2.58)	(3.14)	
P_{18}	-.446	-.908	.127	1.056	.23
	(-1.36)	(-1.33)	(2.47)	(2.92)	
P_{24}	-.854	-2.101	.233	2.036	.22
	(-1.34)	(-1.54)	(2.32)	(2.93)	
P_{36}	-1.829	-3.783	.429	4.477	.21
	(-1.42)	(-1.42)	(2.10)	(3.39)	
P_{60}	-3.980	-8.259	.851	10.306	.21
	(-1.41)	(-1.44)	(1.86)	(3.73)	
B. Sample 54:01-64:07					
P_{13}	-.073	-.113	.037	0.310	.53
	(-2.21)	(-1.69)	(2.48)	(5.02)	
P_{15}	-.182	-.478	.091	0.837	.49
	(-1.70)	(-2.18)	(2.06)	(4.48)	
P_{18}	-.316	-1.211	.165	1.521	.48
	(-1.43)	(-2.74)	(1.84)	(4.14)	
P_{24}	-.656	-2.549	.331	2.745	.51
	(-1.51)	(-3.28)	(1.98)	(4.20)	
P_{36}	-1.565	-4.340	.701	4.919	.55
	(-1.89)	(-3.30)	(2.41)	(4.51)	
P_{60}	-2.692	-8.601	1.252	8.370	.55
	(-1.57)	(-3.36)	(2.26)	(4.46)	

Table 8: Excess Return Regressions for 12-month Holding Periods (cont'd)

C. Sample 64:08-72:12

P_{13}	-.284	.376	.067	-.094	.26
	(-4.50)	(0.75)	(4.09)	(-0.86)	
P_{15}	-.906	1.238	.199	-.302	.33
	(-4.37)	(0.86)	(3.62)	(-0.94)	
P_{18}	-1.951	2.346	.407	-.633	.34
	(-4.45)	(0.86)	(3.52)	(-0.97)	
P_{24}	-4.060	5.063	.821	-1.116	.36
	(-4.46)	(1.06)	(3.46)	(-0.90)	
P_{36}	-8.024	11.588	1.514	-1.169	.35
	(-4.20)	(1.43)	(3.11)	(-0.53)	
P_{60}	-13.223	25.890	2.296	-1.375	.26
	(-3.46)	(1.87)	(2.33)	(-0.34)	

D. Sample 73:01-82:12

P_{13}	-.152	-.390	.029	.205	.15
	(-0.99)	(-0.62)	(1.43)	(1.56)	
P_{15}	-.506	-.897	.076	.673	.13
	(-1.06)	(-0.46)	(1.19)	(1.62)	
P_{18}	-1.002	-2.111	.140	1.272	.11
	(-1.08)	(-0.54)	(1.14)	(1.52)	
P_{24}	-1.870	-4.440	.249	2.361	.10
	(-1.05)	(-0.58)	(1.08)	(1.45)	
P_{36}	-3.413	-8.825	.430	4.836	.10
	(-0.99)	(-0.62)	(0.96)	(1.52)	
P_{60}	-6.802	-22.426	.861	11.219	.12
	(-0.91)	(-0.75)	(0.86)	(1.58)	

E. Sample 82:01-90:02

P_{13}	-.223	-.673	.063	.161	.68
	(-3.09)	(-3.11)	(6.70)	(3.85)	
P_{15}	-.817	-2.002	.198	.485	.69
	(-3.99)	(-3.18)	(7.27)	(3.61)	
P_{18}	-1.681	-4.337	.402	.875	.66
	(-4.44)	(-3.79)	(7.83)	(3.09)	
P_{24}	-3.706	-9.211	.829	1.639	.63
	(-4.84)	(-3.62)	(7.94)	(2.77)	
P_{36}	-7.885	-16.170	1.636	3.676	.57
	(-4.77)	(-2.60)	(7.32)	(3.20)	
P_{60}	-17.303	-36.747	3.519	8.596	.51
	(-4.17)	(-2.00)	(6.81)	(2.94)	

Selected maturities. *t*-statistics, corrected for heteroscedasticity and overlapping data observations, in parentheses. The dependent variable P_τ is the holding period return from buying a τ-month bill at t and selling it as a τ-12 month bill at t+12, less the return on the twelve-month bill. See table 5 for explanatory variable definitions. R^2 is adjusted.

Table 9: Results of Monte Carlo Return Premium Simulations
1-month holding period

Percentage of draws monotonically increasing / hump shaped

A. Scaled Volatility low

		yeild curve slope		
		low	med	high
tbill rate	low	0.3/54.4	15.6/58.0	61.9/26.3
	med	1.3/80.6	52.9/30.8	84.9/11.8
	high	7.1/67.3	37.7/36.6	70.3/20.4

B. Scaled Volatility med

tbill rate	low	0.1/42.4	9.7/65.9	63.0/25.5
	med	0.2/84.4	40.7/37.2	84.6/12.4
	high	3.8/71.8	27.2/44.6	61.1/24.8

C. Scaled Volatility high

tbill rate	low	0.0/20.4	1.4/85.6	54.6/28.7
	med	0.1/64.2	6.5/67.5	62.0/25.5
	high	1.4/75.0	12.4/58.6	44.1/35.2

Table 10: Results of Monte Carlo Return Premium Simulations
3-month holding period

Percentage of draws monotonically increasing / hump shaped

A. Scaled Volatility low

		yeild curve slope		
		low	med	high
tbill rate	low	0.3/43.4	17.8/47.6	86.0/2.9
	med	3.0/80.3	65.8/16.1	98.1/0.6
	high	15.5/58.8	58.2/21.6	90.8/2.6

B. Scaled Volatility med

tbill rate	low	0.1/26.7	8.3/61.5	85.2/2.8
	med	0.1/86.6	52.1/26.0	97.0/0.7
	high	6.7/69.1	44.6/30.5	86.1/4.6

C. Scaled Volatility high

tbill rate	low	0.0/4.3	0.1/78.0	67.3/11.6
	med	0.0/51.9	9.4/65.0	84.2/5.1
	high	1.9/77.3	20.3/50.0	64.4/14.3

Numbers in the table represent percentages of 1000 draws which exhibited each pattern. Low refers to the 20th percentile observed value from the full sample, medium the 50th percentile, and high the 80th percentile.

Table 11: Results of Monte Carlo Return Premium Simulations 6-month holding period

Percentage of draws monotonically increasing / hump shaped

A. Scaled Volatility low

		yeild curve slope		
		low	med	high
tbill rate	low	1.6/47.8	26.1/38.3	76.2/3.6
	med	20.5/53.5	80.5/5.4	97.7/0.1
	high	54.1/21.7	88.9/3.0	98.3/0.1

B. Scaled Volatility med

tbill rate	low	0.1/29.1	12.7/50.9	72.9/4.4
	med	7.3/69.2	72.0/8.6	98.1/0.1
	high	40.5/30.9	80.1/5.5	97.4/0.2

C. Scaled Volatility high

tbill rate	low	0.0/2.2	0.7/55.9	48.3/12.6
	med	0.4/61.3	25.7/38.9	87.2/1.0
	high	17.0/50.9	52.9/20.5	87.0/1.9

Numbers in the table represent percentages of 1000 draws which exhibited each pattern. Low refers to the 20th percentile observed value from the full sample, medium the 50th percentile, and high the 80th percentile.

Table 12: Results of Monte Carlo Return Premium Simulations 12-month holding period

Percentage of draws monotonically increasing / hump shaped

A. Scaled Volatility low

		yeild curve slope		
		low	med	high
tbill rate	low	0.0/13.8	59.2/24.0	100.0/0.0
	med	98.3/1.7	100.0/0.0	100.0/0.0
	high	100.0/0.0	100.0/0.0	100.0/0.0

B. Scaled Volatility med

tbill rate	low	0.0/2.1	0.5/90.6	100.0/0.0
	med	74.1/0.0	100.0/23.9	100.0/0.0
	high	100.0/0.0	100.0/0.0	100.0/0.0

C. Scaled Volatility high

tbill rate	low	0.0/0.1	0.0/66.5	91.7/0.4
	med	0.3/96.5	99.9/0.1	100.0/0.0
	high	100.0/0.0	100.0/0.0	100.0/0.0

Numbers in the table represent percentages of 1000 draws which exhibited each pattern. Low refers to the 20th percentile observed value from the full sample, medium the 50th percentile, and high the 80th percentile.

Figure 1: Confidence intervals for expected premia at different maturities, one-month holding period

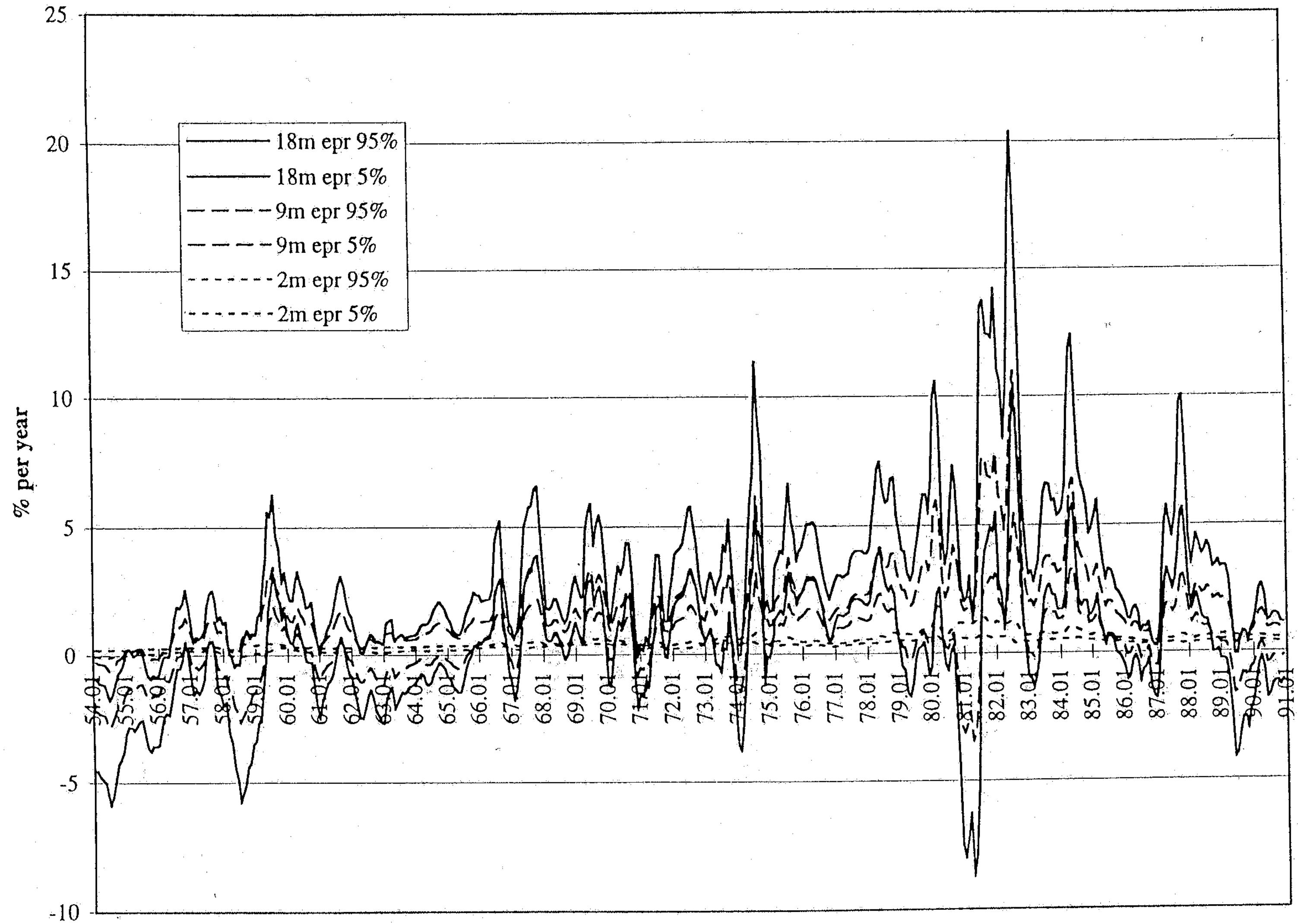


Figure 2: Confidence intervals for expected premia at different maturities, three-month holding period

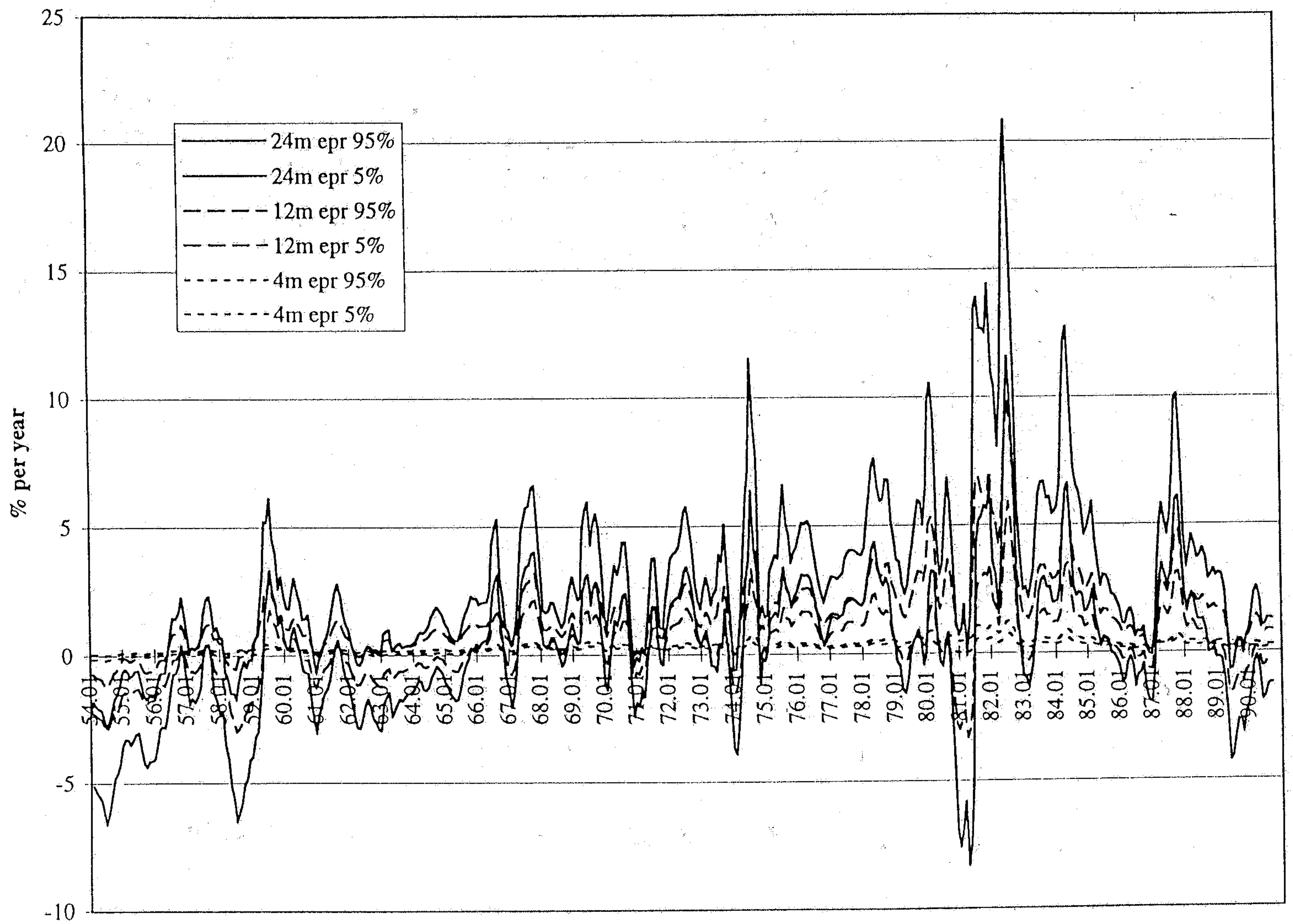


Figure 3: Confidence intervals for expected premia at different maturities, six-month holding period

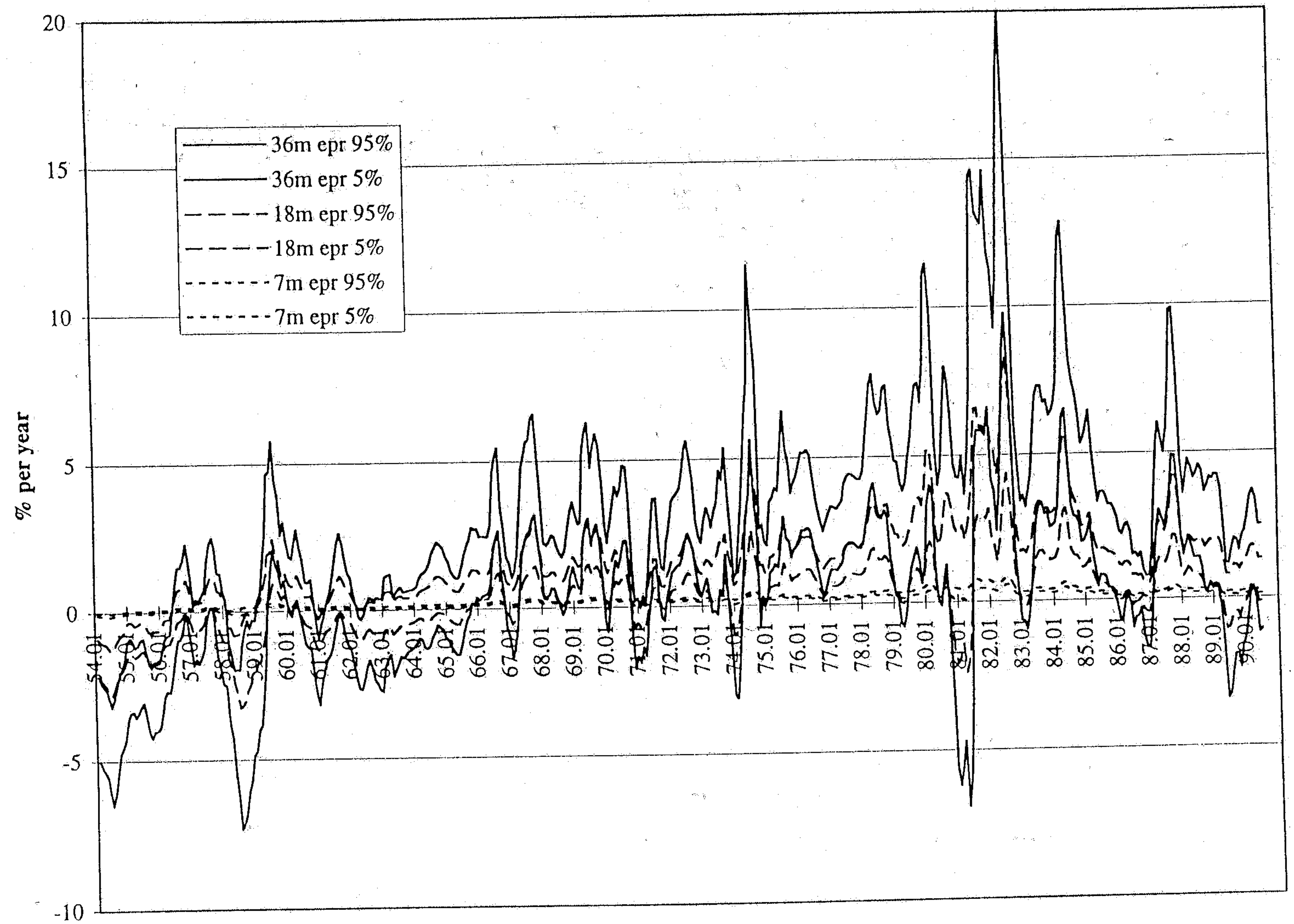
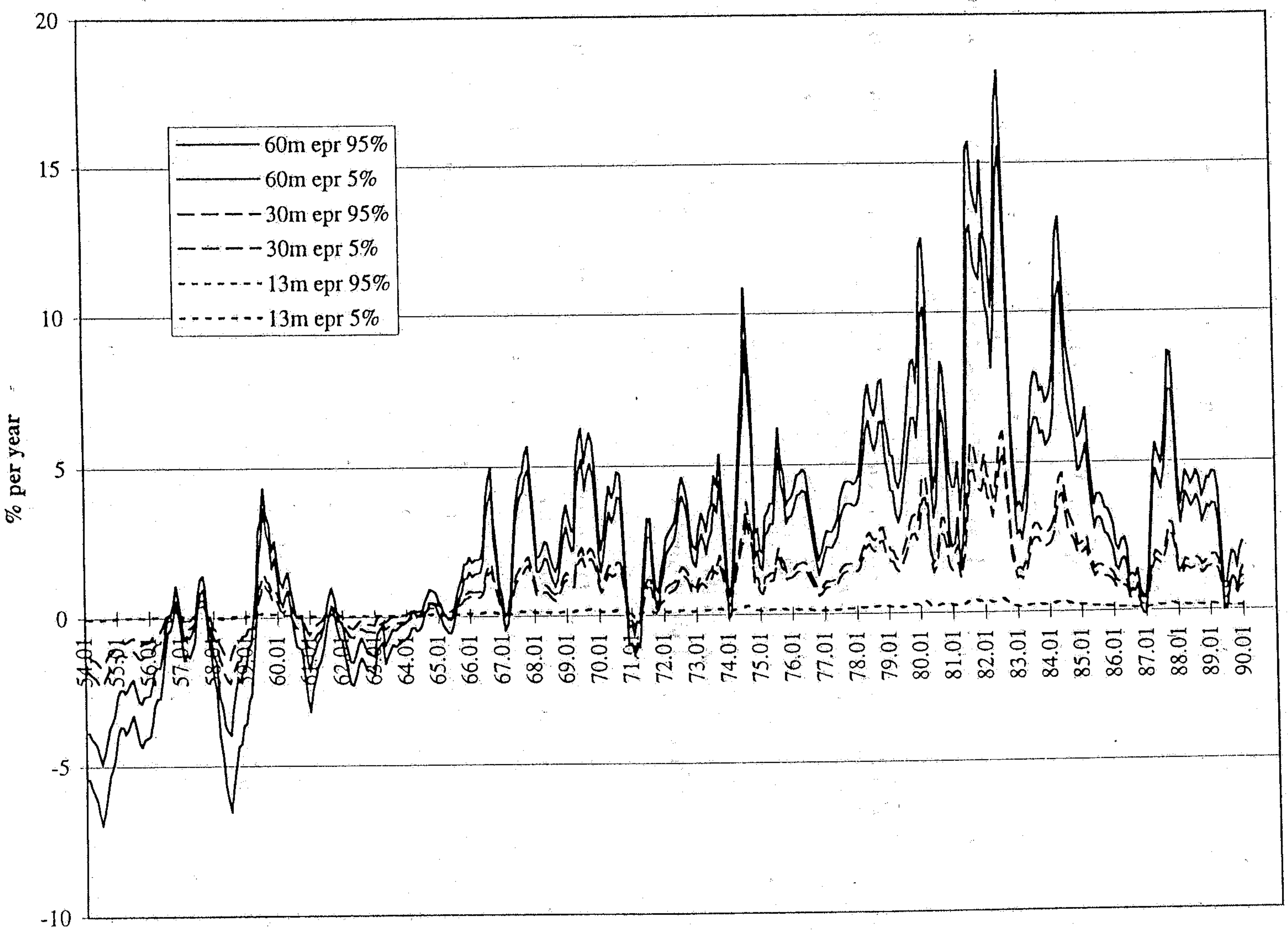


Figure 4: Confidence intervals for expected premia at different maturities, twelve-month holding period



Federal Reserve Bank of Boston - Working Papers

1991 Series

No. 1 "Why State Medicaid Costs Vary: A First Look," by Jane Sneddon Little.

No. 2 "Are Pensions Worth the Cost?" by Alicia H. Munnell. In National Tax Journal, Proceedings of the National Tax Association - Tax Institute of America Symposium "Tax Policy: New Perspectives," May 9 - 10, 1991, vol. XLIV, no. 3 (September 1991), pp. 393-403.

No. 3 "The Capitalization and Portfolio Risk of Insurance Companies," by Richard W. Kopcke.

No. 4 "The Capital Crunch: Neither a Borrower Nor a Lender Be," by Joe Peek and Eric Rosengren. Journal of Money, Credit and Banking, vol. 27, no. 3, August 1995, pp. 625-38.

No. 5 "What Is the Impact of Pensions on Saving? The Need for Good Data," by Alicia H. Munnell and Frederick O. Yohn. In Pensions and the Economy: Sources, Uses, and Limitations of Data, Zvi Bodie and Alicia H. Munnell, eds. University of Pennsylvania Press for the Pension Research Council, 1992.

No. 6 "Treasury Bill Rates in the 1970s and 1980s," by Patric H. Hendershott and Joe Peek. Revision published in Journal of Money, Credit and Banking, vol. 24, May 1992, pp. 195-214.

No. 7 "The Measurement and Determinants of Single-Family House Prices," by Joe Peek and James A. Wilcox. Revision published in Journal of the American Real Estate and Urban Economics Association, vol. 19, no. 3, Fall 1991, pp. 353-82.

No. 8 "Economic Rents, the Demand for Capital, and Financial Structure," by Richard W. Kopcke.

1992 Series -

No. 1 - "Back to the Future: Monetary Policy and the Twin Deficits," by Geoffrey M.B. Tootell.

No. 2 - "The Real Exchange Rate and Foreign Direct Investment in the United States: Relative Wealth vs. Relative Wage Effects," by Michael W. Klein and Eric Rosengren. Revision published in Journal of International Economics, vol. 36, 1994, pp. 373-89.

No. 3 - "Tobin's q, Economic Rents, and the Optimal Stock of Capital," by Richard W. Kopcke.

No. 4 - "The Role of Real Estate in the New England Credit Crunch," by Joe Peek and Eric S. Rosengren. Published as "Bank Real Estate Lending and the New England Capital Crunch," AREUEA, Spring 1994, vol. 22, no. 1, pp. 33-58.

No. 5 - "Failed Bank Resolution and the Collateral Crunch: The Advantages of Adopting Transferable Puts," by Eric S. Rosengren and Katerina Simons. AREUEA, Spring 1994, vol. 22, no. 1, pp. 135-47.

No. 6 - "Defaults of Original Issue High-Yield Bonds," by Eric S. Rosengren. Revision published in Journal of Finance, vol. 48, no. 1, March 1993, pp. 345-62.

No. 7 - "Mortgage Lending in Boston: Interpreting HMDA Data," by Alicia H. Munnell, Lynn E. Browne, James McEneaney, and Geoffrey M.B. Tootell. Revision published in The American Economic Review, vol. 86, no. 1, March 1996, pp. 25-53.

1993 Series

No. 1 - "Assessing the Performance of Real Estate Auctions," by Christopher J. Mayer.

No. 2 - "Bank Regulation and the Credit Crunch," by Joe Peek and Eric Rosengren. Journal of Banking and Finance, vol. 19, no. 1, 1995.

No. 3 - "A Model of Real Estate Auctions versus Negotiated Sales," by Christopher J. Mayer. Journal of Urban Economics, vol. 38, July 1995, pp. 1-22.

No. 4 - "Empirical Evidence on Vertical Foreclosure," by Eric S. Rosengren and James W. Meehan, Jr. Economic Inquiry, vol. 32, April 1994, pp. 1-15.

No. 5 - "Reverse Mortgages and the Liquidity of Housing Wealth," by Christopher J. Mayer and Katerina V. Simons. AREUEA, Summer 1994, vol. 22, no. 2, pp. 235-55.

No. 6 - "Equity and Time to Sale in the Real Estate Market," by David Genesove and Christopher J. Mayer. Forthcoming in The American Economic Review.

1994 Series

No. 1 - "Monetary Policy When Interest Rates Are Bounded at Zero," by Jeffrey Fuhrer and Brian Madigan. Forthcoming in The Review of Economics and Statistics, November 1997 .

No. 2 - "Optimal Monetary Policy in a Model of Overlapping Price Contracts," by Jeffrey C. Fuhrer. Forthcoming in Journal of Money, Credit and Banking.

No. 3 - "Near Common Factors and Confidence Regions for Present Value Models," by Stephen R. Blough.

No. 4 - "Estimating Revenues from Tax Reform in Transition Economies," by Yolanda K. Kodrzycki. Forthcoming in an OECD book, Tax Modeling for Economies in Transition, Macmillan.

No. 5 - "Gifts, Down Payments, and Housing Affordability," by Christopher J. Mayer and Gary V. Engelhardt. Journal of Housing Research, Summer 1996.

No. 6 - "Near Observational Equivalence and Persistence in GNP," by Stephen R. Blough.

1995 Series

No. 1 - "Banks and the Availability of Small Business Loans," by Joe Peek and Eric S. Rosengren.

No. 2 - "Bank Regulatory Agreements and Real Estate Lending," by Joe Peek and Eric S. Rosengren. Real Estate Economics, vol. 24, No. 1(Spring), 1996, pp. 55-73.

No. 3 - "Housing Price Dynamics within a Metropolitan Area," by Karl E. Case and Christopher J. Mayer. Regional Science and Urban Economics, vol. 26, nos. 3-4, June 1996, pp. 387-407.

No. 4 - "Tobin's q, Economic Rents, and the Optimal Stock of Capital," by Richard W. Kopcke.

No. 5 - "Small Business Credit Availability: How Important Is Size of Lender?" by Joe Peek and Eric S. Rosengren. In A. Saunders and I. Walter, eds., Financial System Design: The Case for Universal Banking, 1996. Homewood, IL: Irwin Publishing.

No. 6 - "The (Un)Importance of Forward-Looking Behavior in Price Specifications," by Jeffrey C. Fuhrer. Forthcoming in the Journal of Money, Credit and Banking.

No. 7 - "Modeling Long-Term Nominal Interest Rates," by Jeffrey C. Fuhrer. Quarterly Journal of Economics, November 1996.

No. 8 - "Debt Capacity, Tax-Exemption, and the Municipal Cost of Capital: A Reassessment of the New View," by Peter Fortune.

No. 9 - "Estimating Demand Elasticities in a Differentiated Product Industry: The Personal Computer Market," by Joanna Stavins. Forthcoming in Journal of Economics and Business.

No. 10- "Discrimination, Redlining, and Private Mortgage Insurance," by Geoffrey M.B. Tootell.

No. 11- "Intergenerational Transfers, Borrowing Constraints, and Saving Behavior: Evidence from the Housing Market," by Gary V. Englehardt and Christopher J. Mayer.

No. 12- "A New Approach to Causality and Economic Growth," by Steven M. Sheffrin and Robert K. Triest.

1996 Series

No. 1 - "The International Transmission of Financial Shocks," by Joe Peek and Eric S. Rosengren.

No. 2 - "Computationally Efficient Solution and Maximum Likelihood Estimation of Nonlinear Rational Expectations Models," by Jeffrey C. Fuhrer and C. Hoyt Bleakley.

No. 3 - "Derivatives Activity at Troubled Banks," by Joe Peek and Eric S. Rosengren.

No. 4 - "The Maturity Structure of Term Premia with Time-Varying Expected Returns," by Mark A. Hooker.

No. 5 - "Will Legislated Early Intervention Prevent the Next Banking Crisis?" by Joe Peek and Eric S. Rosengren.

No. 6 - "Redlining in Boston: Do Mortgage Lenders Discriminate Against Neighborhoods?" by Geoffrey M.B. Tootell.

No. 7 - "Price Discrimination in the Airline Market: The Effect of Market Concentration," by Joanna Stavins.

No. 8 - "Towards a Compact, Empirically Verified Rational Expectations Model for Monetary Policy Analysis," by Jeffrey C. Fuhrer.

No. 9 - "Tax-Exempt Bonds Really Do Subsidize Municipal Capital!" by Peter Fortune.

No.10- "Can Studies of Application Denials and Mortgage Defaults Uncover Taste-Based Discrimination?" by Geoffrey M.B. Tootell.