The Effects of Inverted Yield Curves on Asset Returns

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Abstract

Between 1954 and 1991, U.S. stocks, long-term government bonds, and corporate bonds show negative risk premiums during periods preceded by inverted yield curves. Intermediate-term government bonds do not. Going from safer to riskier asset classes, the negative risk premiums increase in absolute value and statistical significance. The consumption CAPM offers a possible explanation for the negative risk premiums. A negative covariance between the growth rate of consumption and the premium on the risky assets will result in a negative risk premium. Empirical tests of the conditional covariance show that the consumption CAPM does not explain the phenomena.

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1. Introduction

Recent empirical research by Boudoukh, Richardson, and Smith (1993), and Ostdiek (1998) shows that the ex ante expected returns on stocks are less than the risk-free rate in some states of the world. Boudoukh, Richardson, and Smith (1993) analyze U.S. stocks and Ostdiek a portfolio of world stocks. These authors conclude that risk premiums are most likely to be negative in periods that are preceded by inverted yield curves.

There has been extensive empirical work concerning the effects of the yield curve on stock risk premiums, including Fama and French (1989), Chen (1991), and many others. In all cases that I am aware of, the results indicate a positive relation between the size of the term spread and the risk premium. Fama and French show that the risk premium should be lower than average when the term spread is low, but do not specifically examine periods when the term spread is negative. Only Boudoukh, Richardson, and Whitelaw (1997) investigate the question of why the risk premiums are negative when the term spread is negative. Can this phenomenon be explained by asset pricing theory?

Primary objectives of my research are to extend the risk premium literature to include fixed income assets, to see if negative risk premiums also occur for these securities, and to determine whether the phenomena are sensitive to the length of the investment horizon. Using monthly and quarterly data for returns on stocks, corporate bonds, long-term government bonds, and intermediate-term government bonds from 1954 to 1991 shows an interesting progression. When the yield curve is inverted, the negative risk premiums increase in absolute value and statistical significance as asset classes progress from safer to riskier. Stocks show the most negative risk premium of the four assets, followed by corporate bonds, and then long-term government bonds. Both corporate and long-term government bonds have negative risk premiums, but with weaker statistical significance than is the case with stocks. The risk premiums for intermediate-term government bonds are positive and just below those obtained during periods when the yield curve is upward-sloping. The inverted yield curve signals negative risk premiums for long-term financial assets, but the degree of negativity depends on the riskiness of the asset.

The second objective of my research is to test a potential explanation for the occurrence of the negative risk premiums. I base my testing on Breeden's (1979) consumption capital asset pricing model (CAPM). Assuming that investors are risk averse, a negative covariance between the growth rate of consumption and the risk premium could result in a negative risk premium. Using a stylized model, Boudoukh, Richardson, and Whitelaw (1997) show how this is theoretically possible, but do not test the actual consumption data. I test the signs of the covariances between the growth rate of consumption and the risk premiums of the assets to see if they are negative in periods preceded by inverted yield curves. My results do not support the consumption CAPM. Using the generalized method of moments (GMM), I find that the conditional covariance between risk premiums on each asset and the consumption growth rate are sometimes positive and sometimes negative, but never statistically different from zero.

The paper proceeds as follows: Section 2 outlines the theory concerning the sign of the risk premium. Section 3 describes the data. Section 4 looks at conditional and unconditional risk premiums of the assets. Section 5 examines the relation between each asset's risk premium and consumption growth. Section 6 concludes.

2. Should Risk Premiums Always Be Positive?

Are ex ante expected returns on risky assets always higher than the certain return on a risk-free asset? The results of Boudoukh, Richardson, and Smith (1993), Ostdiek (1998), and this research show that this is not necessarily the case. Further, it is possible to support these empirical results with financial theory. A dynamic, consumption-based asset pricing model, such as Breeden's (1979) consumption CAPM, can predict a negative risk premium for any asset, including the market portfolio. The first-order conditions for an individual's optimal consumption and portfolio plan imply that:

$$E_t\left[(R_{it+1} - R_{ft})\left(\frac{U'(C_{t+1})}{U'(C_t)}\right)\right] = 0 \tag{1}$$

where $U'(.)$ is marginal utility and C_t is consumption at Time t. The expression $\frac{U'(C_{t+1})}{U'(C_t)}$ is the intertemporal marginal rate of substitution, which I abbreviate as M_{t+1}. R_{it+1} is the return on any risky asset, which could be the market portfolio. R_{ft} is the return on a risk-free asset.

Applying the definition of covariance to (1), noting that $E[M_{t+1}] = 1/R_{ft}$, and rearranging I get:

$$E_t[R_{i,t+1} - R_{ft}] = -R_{ft}Cov_t(R_{i,t+1}, M_{t+1}).$$

(2)

If the conditional covariance between the return on the risky asset and investors' intertemporal marginal rate of substitution is positive in some state of the world, then equation (2) implies that the conditional expectation of the risk premium is negative in those states.

Boudoukh, Richardson, and Whitelaw (1997) note that it is theoretically possible for this covariance to be positive, even for the market portfolio or a large subset of it. The sign of the covariance between the risky asset return and the IMRS can be decomposed into the product of two terms. The first term is the sign of the covariance between the IMRS and consumption in Period t+1. The second term is the sign of the covariance between the risky asset return and consumption in Period t+1. If the utility function is strictly concave, the covariance between the IMRS and next period's consumption is negative.

Intuition suggests that the covariance between the risky asset return and consumption in Period t+1 should be positive, but Boudoukh, Richardson, and Whitelaw (1997) note that this is not necessarily true. The asset's return consists of two components, a dividend return and a capital gain or loss. Even if the dividend return is positively related to consumption growth, the capital gain or loss might be negatively related to expected future growth rates of consumption. This is because high consumption growth can increase the discount rate proportionally more than expected future dividends. The increase in the discount rate would lead to a capital loss, which could dominate the positive dividend return. Therefore, if the covariance between the risky asset return and consumption growth were negative, the consumption CAPM would predict a negative risk premium.

Boudoukh, Richardson, and Whitelaw (1997) developed a stylized model in which they showed how the risk premium can be negative, given certain assumptions of the consumption/dividend stream, but did not directly test the asset returns with the consumption data. As explained in the introduction, it is one of the purposes of this research to determine whether or not the actual U.S. consumption data can support the prediction of the consumption CAPM.

I can derive an expression equivalent to equation (2) by using another approach: Taking a first-order Taylor series expansion of the numerator of the IMRS around C_t gives me:

$$\frac{U'(C_{t+1})}{U'(C_t)} \approx \frac{U'(C_t) + (C_{t+1} - C_t)U''(C_t)}{U'(C_t)}. \tag{3}$$

Rearranging the RHS of (3) I get:

$$\frac{U'(C_t) + (C_{t+1} - C_t)U''(C_t)}{U'(C_t)} = 1 - \left(\frac{-C_t U''(C_t)}{U'(C_t)}\right)\left(\frac{C_{t+1} - C_t}{C_t}\right). \tag{4}$$

Let $b = \left(\frac{-C_t U''(C_t)}{U'(C_t)}\right)$ denote the aggregate relative risk aversion, which is nonstochastic

because it depends only on C_t, which is known at Time t. Let $c^*_{t+1} = \left(\frac{C_{t+1} - C_t}{C_t}\right)$ denote the

growth rate of consumption. Combine equation (1) with equations (3) and (4), and ignore the approximation to get:

$$E_t[(R_{i,t+1} - R_{ft})(1 - bc^*_{t+1})] = 0. \tag{5}$$

Applying the definition of covariance, rearranging, and taking the limit to continuous time, I get:

$$E_t[R_{i,t+1} - R_{ft}] = bCov_t(R_{i,t+1} - R_{ft}, c^*_{t+1}). \tag{6}$$

Equation (6) suggests two possible explanations for negative ex ante risk premiums. The covariance between the risk premium and the growth rate of consumption might be negative in those states of the world, or the relative risk aversion might be negative, but not both. If both are positive or both are negative, then the risk premium will be positive.

Over the long run, the covariance in (6) should be positive. However Cornell (1981) shows that the conditional relation need not be constant. It is theoretically possible for the relation to be positive in some states of the world and negative in others.

3. Description of the Data

For the computation of the risk premiums, I examine monthly and quarterly investment horizons. Since Boudoukh, Richardson, and Smith (1993) used annual investment horizons, I examine the shorter periods to determine if the results are sensitive to the length of the holding period. The data run from January 1954 to March 1991. The beginning of the period was chosen to avoid the time interval when government bond interest rates were pegged by the Federal Reserve. The end of this period was dictated by the availability of the term structure data from McCulloch and Kwon (1993).

The consumption data are the quarterly real consumption of nondurables and services reported by the Commerce Department. The data are converted to a per capita basis by dividing by the average total U.S. population during the quarter. The consumption and population data are obtained from Citibase.

The term structure data are from McCulloch and Kwon (1993). I use yields on coupon bonds for the long-term instruments rather than the yields on pure discount bonds, because investors actively follow coupon bond rates. It is difficult to define what constitutes an inverted yield curve, because the curve is not always monotonically increasing or decreasing. To capture the varying effects of short-term versus long-term yields on government debt instruments, I use the differences in yields between two different pairs of maturities: Five-year Treasury notes minus one-year Treasury bills, and 13-year Treasury bonds minus one-month Treasury bills. 13-year Treasury bonds are used because they are the longest maturity for which there were bonds always outstanding over the entire period from 1954 to 1991. The intermediate (Five-year / one-year) term spread is negative more often than the long-term (13 year / one-month) spread. From 1954 to 1991, 98 months out of 447 were preceded by negative intermediate-term spreads. Fortyseven months were preceded by negative long-term spreads. The two term spreads are graphed in Figure 1.

(Insert figure 1 here)

As is seen in Figure 1, inverted yield curves generally coincide with the peak of the business cycle. The long-term spread is almost always the larger of the two. Despite the differences between the two spreads, the results of the empirical tests using the two are approximately the same. Therefore I report only the results using the intermediate term spread.

Returns on stocks are the monthly CRSP value-weighted portfolio returns, including dividends. Holding period returns on long- and intermediate-term government bonds and on corporate bonds are drawn from Ibbotson (1994), who computes the corporate bond returns from the Salomon Brothers Long-Term High-Grade Corporate Bond Index. This index uses Aaa- and Aa-rated bonds and assumes a maturity of 20 years. Ibbotson computes the government bond returns from data obtained from the CRSP government bond file and from *The Wall Street Journal*. The long-term government bond returns represent holding period returns from Treasury bonds with maturities that average approximately 20 years. The intermediate term bonds are for Treasury notes of approximately five years.

I compute the risk premiums as the excess of the risky asset returns over the Treasury bill return for the corresponding interval. I obtain the T-bill returns from the CRSP database. For monthly returns, I use the T-bill with the maturity closest to 30 days. For quarterly returns, I use the T-bill with the maturity closest to 90 days. The returns on the T-bills are adjusted to conform to the actual number of days in each time period.

4. Conditional and Unconditional Risk Premiums on Assets

Table 1 shows the unconditional returns on the securities from 1954 to 1991. I use arithmetic means in all cases. The risk premium on stocks is positive and averages nearly 7% on an annualized basis. The risk premium on corporate bonds is positive, but barely above zero. The risk premium on long-term government bonds is also very close to zero. Intermediate-term government bonds have higher risk premiums than either of the long-term bonds. Returns on stocks have the highest standard deviation of the four asset classes and intermediate-term government bonds the lowest. Surprisingly, returns on long-term government bonds have a *higher* standard deviation than do long-term corporate bonds. This phenomenon has also been reported by Ibbotson (1994) for the period from 1926 to the present.

It is also interesting to look at the cross-correlations between the excess returns of the different asset classes in Table 2. The correlation between long-term government bonds and corporate bonds is very high: 0.89 for monthly returns and 0.94 for quarterly returns. Correlations between stocks and each of the three types of bonds show an intuitive progression. The correlation between stocks and corporate bonds is the highest, followed by long-term government bonds and then intermediate-term government bonds.

Table 3 shows the conditional risk premiums for each asset class under both normal and inverted yield curves. [1] The conditional risk premiums for stocks are positive when the yield curve is normal and negative when inverted. The Z-statistic measures the difference between the risk premiums in the two states of the world and is significant at the 99% level. The risk premiums for corporate bonds and long-term government bonds go from positive to negative, but

[1] Boudoukh, Richardson, and Smith (1993) use two transformations of the yield curve instrument, a simple average of the risk premiums when the yield curve is inverted, and a weighted average that makes use of the magnitude of the term spread when the yield curve is inverted. I compute the conditional risk premiums using both of these methods, and find that the results are approximately the same for both. I report only the results using the first method.

the difference is statistically insignificant. The risk premiums for intermediate-term government bonds become lower (but still positive) when the yield curve is inverted, but the difference is miniscule. In a related finding, Brocato and Steed (1998) show how the risk/return profile of a portfolio can be improved by keying asset proportions to changes in the business cycle, and we see in Figure 1 how the business cycle relates to yield curve inversions.

Figures 2 and 3 show the graphs of the risk premiums for U.S. stocks and corporate bonds, alongside the term spread. The graph for long-term government bonds (not shown) is very similar to that of corporate bonds. The graphs show the positive relation between the term spread and the risk premiums. [2]

(Insert figures 2 and 3 here)

When the yield curve is inverted, the conditional risk premiums for the four assets show an interesting progression. The risk premium *decreases* as we move from intermediate-term government bonds to long-term government bonds to corporate bonds to stocks. Also, there is an increase in the statistical significance of the differences of the risk premiums. Why do the riskiest assets have the lowest risk premiums? Stocks, corporate bonds, and long-term government bonds are all long-term investments and all have negative risk premiums signaled by the inverted yield curve. Fama and French (1989) discuss how the yield curve is a proxy for discount rate risk, which is higher for long-term assets such as stocks and long-term bonds than it is for shorter-term assets such as Treasury notes. The risk is low near business cycle peaks and high near troughs. This does not explain why the risk premium should be negative at the peaks, only that it

[2] I have also examined the conditional risk premiums for two world portfolios as compiled by MSCI [local currency and dollar-denominated] (not shown) and find that the results are nearly identical to those obtained for U.S. stocks. U.S. stocks comprise 40% of the market value of the world portfolio in 1993, and much more than that in earlier years. The correlation between the returns on US stocks and each of the two world portfolios is approximately 0.9 during the period from 1970 to 1991. Like Ostdiek (1998), I find that there is not much difference between the

should be lower than average. The long-term assets always have greater sensitivity to discount rate shocks, but Table 3 shows that the effect of the inverted yield curve is much stronger for stocks than for the other two long-term assets. Therefore, discount rate risk cannot completely explain the phenomenon.

Another possible explanation for the negative risk premiums concerns the sign of the coefficient of relative risk aversion. Equation (6) shows that a negative risk premium results if the conditional covariance is positive and the relative risk aversion is negative. If investors' relative risk aversion is not constant, non-risk averse behavior on the part of some investors could cause the risk premiums to become negative when the yield curve inverts. Figure 1 shows that inverted yield curves occur at or near the peak of the business cycle, when risk aversion would be at a minimum.

There is some theoretical justification for variable risk aversion. Chen (1991) argues that risk aversion is inversely related to investor wealth. Campbell and Cochrane (1995) develop a model in which there is countercyclical variation in the risk aversion level. However, it is very unlikely that a sufficient number of investors could become risk-loving to make the aggregate coefficient of relative risk aversion negative. Certainly some people do act as risk lovers, at least some of the time, but it is doubtful that enough do.

To further explore the relation between the risk premiums and the riskiness of the asset classes, I test the distributions of the assets for second-degree stochastic dominance relations. In many ways, stochastic dominance is an excellent method for comparing the relative risk of two assets. It is a nonparametric technique, and the only assumption about the investors' utility functions that needs to be made is risk aversion. The chief drawback of stochastic dominance is

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results of the dollar-denominated portfolio and the local-currency-denominated portfolio. Currency exchange rates that it assumes that there is only one source of risk and does not consider the cross-correlations among the various assets.

Let F(x) be the cumulative distribution function (CDF) of the returns of asset A and G(x) be the CDF of asset B. Asset A is said to dominate asset B in the sense of second degree stochastic dominance (A SSD B) if:

$$\int_{-\infty}^{y} F(x)dx \leq \int_{-\infty}^{y} G(x)dx \qquad \forall\ y. \tag{7}$$

If this condition holds, then all risk averse investors will prefer A over B. Using the definition of increasing risk devised by Rothschild and Stiglitz (1970), asset B is considered riskier than asset A if the two distributions have equal means and A SSD B. If this is the case, then B will have greater variance than A. However, stochastic dominance represents a much stronger condition than merely comparing the variances, since it takes into account all aspects of the distributions. For more information about stochastic dominance, see Hadar and Russell (1969).

Seyhun (1993) shows how the sample distributions of returns on two assets can be tested to determine whether or not a stochastic dominance relationship exists. Using Seyhun's methodology, I construct an empirical CDF for each asset by using the sample returns, and then examine the CDFs to see if the relation in equation (7) holds between the two distributions. For this purpose, the means of the distributions of each asset are equalized by adding an appropriate constant to each period's return before the stochastic dominance relation is tested. This allows me to determine if one asset is riskier than another under the definition of Rothschild and Stiglitz (1970).

Table 4 shows the results of the stochastic dominance tests. The returns on T-bills dominate the four risky assets. Intermediate-term government bonds dominate long-term

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do not have a significant impact on the results.

government and corporate bonds, and stocks. Both long-term government bonds and corporate bonds dominate stocks, but there is no relation between the two types of long-term bonds.

Table 1 shows that the standard deviation for long-term government bonds is larger than for corporate bonds. This is surprising, since the two types of bonds have the same amount of discount rate risk and the corporate bonds have greater default risk. Moreover, Ibbotson (1994) computed both series of returns using maturities of approximately 20 years, so there is little or no difference in the duration of the two types of bonds. The default risk in the corporate bonds must be hedging the discount rate risk to some extent.

Moving from intermediate-term government bonds to long-term bonds to stocks, there is a progression in general riskiness. At the same time, the conditional risk premiums decrease as we go from safer to riskier assets. It is reasonable to assume that stocks have approximately the same amount of discount rate risk as the two types of long-term bonds. Since the conditional risk premiums for stocks are higher than they are for bonds when the yield curve is normal and lower when the yield curve is inverted, it is clear that the yield curve is a proxy for some other risk factor or factors in addition to the discount rate risk, such as possible changes in the investment opportunity set as described in the intertemporal CAPM of Merton (1973). Both Merton (1973) and Breeden (1979) have shown how the intertemporal CAPM is theoretically equivalent to the consumption CAPM. The investor can hold various assets to hedge against changes in her investment opportunity set, or to hedge against changes in her consumption stream.

5. Relations Between Asset Risk Premiums and Consumption

Table 5, Panel A, shows the quarterly growth rate of real, per capita consumption of nondurables and services from 1954 to 1991. The growth rate has an arithmetic mean of 1.98%

on an annualized basis. Breaking this down into subsets according to the sign of the term spread yields an interesting result. Panel B shows that those quarters preceded by negative term spreads have lower consumption growth rates. Estrella and Mishkin (1996) determine that inverted yield curves are often leading indicators of a recession, therefore consumption growth rates are lower in periods following the inversion. Looking at the conditional growth rate of consumption from the quarter *after* the negative term spreads occurred to the following quarter, I obtain similar results. These results are shown in panel C.

I want to determine if the negative risk premiums are associated with negative covariance with the growth rate of consumption. To do this, I use quarterly consumption data. There are monthly consumption data available beginning in 1959, but these are rough estimates based on retail sales. Ideally, I would like to compare risk premiums on assets from the beginning to the end of the quarter with the growth of the spot consumption rate from the beginning to the end. However, the consumption data are not the rates at points in time, but integrals of the rate over a quarter. Thus, if I assume that the average consumption rate for Quarter t-1 equals the spot rate at the beginning of Quarter t, and that the average consumption rate for Quarter t equals the spot rate at the end of Quarter t, then I would compute the growth rate as the change in consumption from Quarter t-1 to Quarter t, divided by Quarter t-1. Call this lagged growth rate c_t^*.

There is another possible method. If I assume that the average consumption rate for Quarter t equals the spot rate at the beginning of Quarter t, and that the average consumption rate for Quarter t+1 equals the spot rate at the end of Quarter t, then I would compute the growth rate as the change in consumption from Quarter t to Quarter t+1, divided by Quarter t. Call this leading growth rate c_{t+1}^*.

I test the time series of both the risk premiums of the assets and the consumption growth rate for stationarity (not shown). All of the time series strongly reject the null hypothesis of unit root nonstationarity.

Table 6 shows the covariances between the consumption growth rate and risk premiums on the assets, conditional on the sign of the term spreads. I compute the covariances using the generalized method of moments. I use the technique of Andrews and Monahan (1992) to obtain standard errors that are adjusted for heteroskedasticity and autocorrelation. Table 6, Panel A uses the lagged consumption growth rate c_t^*, and Panel B shows the results using the leading c_{t+1}^* consumption growth rate. Some of the conditional covariances are positive and some are negative, but all are statistically indifferent from zero.

The statistically insignificant covariances show that the consumption data cannot explain very much of the variation of risk premiums. Grossman and Shiller (1981) and many others also find this result. The consumption CAPM does not explain the negative risk premiums, nor does consumption growth show much of any relation to asset returns at all. Why does the consumption CAPM repeatedly fail empirical tests? Undoubtedly because the underlying assumptions of the model are unrealistic, for example, the requirement that each individual’s consumption stream is an increasing function of the aggregate consumption stream. If there were an extensive cross-sectional database of individual consumption and investment portfolio data, perhaps the issue could be resolved conclusively.

6. Conclusions

During periods preceded by inverted yield curves, negative risk premiums occur for a variety of long-term financial assets. My research confirms the findings of Boudoukh, Richardson, and Smith (1993) and Ostdiek (1998) and shows that the results are robust to the length of the investment horizon. The degree of negativity increases with the general riskiness of the asset. The riskiest asset has the lowest, most statistically significant risk premium. Intermediate-term government bonds do not have the negative risk premiums, and investors can safely hold these securities even when a yield curve inversion appears imminent. The consumption CAPM cannot explain the phenomenon of the negative risk premiums. This confirms the findings of other researchers, such as Mankiw and Shapiro (1986), who show that the model fails to adequately explain returns on securities.

The differences in the conditional risk premiums between long-term bonds and stocks show that at best, the discount rate risk is only a partial explanation for the negative risk premiums that stocks display. An alternate explanation for the negative risk premiums involves non-risk-averse behavior, but such a scenario is very unlikely. A more plausible explanation lies in some unknown risk factor, as illustrated in Merton's (1973) intertemporal CAPM. Although both Merton and Breeden (1979) have shown that the ICAPM and CCAPM are theoretically equivalent, some of the assumptions underlying the CCAPM are unrealistic, resulting in a model that has never tested well. Future research should look for the unknown risk factor that manifests itself when the yield curve inverts.

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Table 1

Unconditional Returns on Assets

All returns are annualized.

Monthly Data: 1/54 - 3/91 (447 months): Asset Class	Mean return	Standard Deviation	Mean return 30-day T-bills	Risk Premium
Stocks	12.25 %	51.62 %	5.37 %	6.88 %
Long-Term Corporate Bonds	6.11	29.50	5.37	0.74
Long-Term Government Bonds	5.64	32.76	5.37	0.27
Intermediate-Term Government Bonds	6.41	18.65	5.37	1.04

Quarterly Data: 1Q/54 - 1Q/91 (149 quarters): Asset Class	Mean return	Standard Deviation	Mean return 30-day T-bills	Risk Premium
Stocks	12.62 %	33.08 %	5.81 %	6.81 %
Long-Term Corporate Bonds	6.25	19.98	5.81	0.44
Long-Term Government Bonds	5.75	21.01	5.81	-0.06
Intermediate-Term Government Bonds	6.48	12.24	5.81	0.67

Table 2

Unconditional Correlations between Asset Risk Premiums: 1954 - 1991

Correlations and standard errors (not shown) estimated using the generalized method of moments. All correlations are at least two standard errors different from zero.

Monthly data	Stocks	Long-Term Corporate Bonds	Long-Term Government Bonds	Intermediate-Term Government Bonds
Stocks	1.000			
Long-Term Corporate Bonds	0.3349	1.000		
Long-Term Government Bonds	0.2695	0.8949	1.000	
Intermediate-Term Government Bonds	0.2012	0.8188	0.8534	1.000

Quarterly data	Stocks	Long-Term Corporate Bonds	Long-Term Government Bonds	Intermediate-Term Government Bonds
Stocks	1.000			
Long-Term Corporate Bonds	0.3624	1.000		
Long-Term Government Bonds	0.3059	0.9429	1.000	
Intermediate-Term Government Bonds	0.2406	0.9281	0.9367	1.000

Table 3

Conditional Risk Premiums of Assets: Periods Preceded by Inverted Yield Curves

All risk premiums are annualized. The z-statistic and associated p-value are for the test of the null hypothesis $R_N = R_I$, where R_N is the risk premium conditional on the preceding yield curve being upward-sloping, and R_I is the risk premium conditional on the preceding yield curve being inverted.

Monthly Data	Risk Premium when Yield Curve Is Normal	Risk Premium when Yield Curve Is Inverted	Z-stat	p-value
Stocks	10.97 %	-7.65 %	2.834	0.005
Long-Term Corporate Bonds	1.60	-2.35	0.968	0.332
Long-Term Government Bonds	0.72	-1.32	0.470	0.638
Intermediate-Term Government Bonds	1.09	0.84	0.090	0.928

Quarterly Data	Risk Premium when Yield Curve is Normal	Risk Premium when Yield Curve is Inverted	Z-stat	p-value
Stocks	11.15 %	-7.28 %	2.799	0.005
Long-Term Corporate Bonds	1.20	-2.02	0.668	0.503
Long-Term Government Bonds	0.32	-1.31	0.336	0.740
Intermediate-Term Government Bonds	0.68	0.63	0.017	0.984

Table 4

Tests of Second-Degree Stochastic Dominance Relationships Between Asset Classes

An entry of SSD in the table means that the distribution of returns for the asset on the left dominates the asset on the top in the sense of second-degree stochastic dominance, after the means of the distributions are equalized.

Monthly Data	Stocks	Long-Term Corp. Bonds	Long-Term Govt. Bonds	Int.-Term Govt. Bonds
Stocks	--------			
Long-Term Corporate Bonds	SSD	--------------		
Long-Term Government Bonds	SSD	Neither Dominates	---------------	
Intermediate-Term Government Bonds	SSD	SSD	SSD	---------------
Treasury Bills	SSD	SSD	SSD	SSD

Quarterly Data	Stocks	Long-Term Corp. Bonds	Long-Term Govt. Bonds	Int.-Term Govt. Bonds
Stocks	--------			
Long-Term Corporate Bonds	SSD	--------------		
Long-Term Government Bonds	SSD	Neither Dominates	---------------	
Intermediate-Term Government Bonds	SSD	SSD	SSD	---------------
Treasury Bills	SSD	SSD	SSD	SSD

Table 5

Real per Capita Consumption Growth (Nondurables and Services)
1954 - 1991

All figures are annualized growth rates from quarterly data.

A: *Unconditional:*	
Average growth rate, 1Q/54 - 1Q/91 (149 quarters)	1.98 %
B: *Conditional: lagged consumption growth from Quarter (t-1) to t*	
Average growth rate, 35 quarters with negative term spreads at the end of Quarter (t-1)	1.02 %
114 quarters with positive term spreads	2.28 %
C: *Conditional: leading consumption growth from Quarter t to (t+1)*	
Average growth rate, 35 quarters with negative term spreads at the end of Quarter (t-1)	0.79 %
114 quarters with positive term spreads	2.34 %

Table 6

Conditional Covariance of Asset Risk Premiums with Real per Capita Consumption Growth: 1954 to 1991

$R_{i,t+1}$ is the return on the asset. R_{ft} is the riskfree rate. c_t^* is the growth rate of real, per capita consumption of nondurables and services. Robust standard errors are computed using the method of Andrews and Monahan (1992). Covariances are conditional on the yield curve being inverted at the end of the previous quarter. All data are quarterly.

A: $Cov_t(R_{i,t+1} - R_{ft}, c_t^*)$		
Lagged consumption growth rate c_t^*		
	Covariance	Standard Error
Stocks	0.000019	0.000086
Long-Term Corporate Bonds	-0.000062	0.000086
Long-Term Government Bonds	-0.000076	0.000077
Intermediate-Term Govt Bonds	-0.000044	0.000047

B: $Cov_t(R_{i,t+1} - R_{ft}, c_{t+1}^*)$		
Leading consumption growth rate c_{t+1}^*		
	Covariance	Standard Error
Stocks	0.000095	0.000099
Long-Term Corporate Bonds	0.000056	0.000083
Long-Term Government Bonds	0.000052	0.000084
Intermediate-Term Govt Bonds	0.000025	0.000051