What Really Happened to U.S. Bond Yields

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Analysts have been able to say surprisingly little about the sources of the very volatile yields of long-term U.S. bonds in recent decades. We used surveys of economists' forecasts to decompose long-term bond yields into expectations of future inflation, expected real short-term interest rates, and the expected bond risk premium. Variation in the bond risk premium accounts for most of the variation in yields from period to period, but declines in all three components have contributed to the decline in yields of the past decade and a half.

Long-term U.S. government bond yields have been very volatile in recent decades; yet, analysts can say surprisingly little about the sources of the yield fluctuations. Analysts know that changes in nominal yields from period to period must stem from some combination of changes in investor expectations of future inflation and changes in the real returns that investors demand. These components of bond yields are unobservable, however, and analysts cannot say what really has caused the fluctuations in yields. In this study, we used surveys of economists' long-term forecasts to estimate the components of bond yields and tentatively identify the causes of changes in yields.

The surveys came from *Blue Chip Economic Indicators*, which has published a survey of economists' forecasts each month since August 1976. *Blue Chip* obtains forecasts from about 50 economists at major financial institutions, industrial corporations, and consulting firms of key variables for the U.S. economy for one to two years in the future. Since 1983, the survey has been extended to cover the economists' long-term (10-year) forecasts for economic variables, including inflation and three-month U.S. Treasury bill rates.[1] We assumed that the economists' forecasts are a valid proxy for investors' expectations and, therefore, that we could use the long-term inflation forecasts to decompose 10-year T-bond yields into two parts: expectations of future inflation and expectations of future real returns. A novel aspect of our work is that by also using the economists' long-term forecasts of three-month T-bill rates, we could further decompose the real return into expectations of real short-term interest rates and a risk premium for investing in the long-term bond rather than T-bills.[2]

Using survey data in an analysis of this type involves a number of potential pitfalls. As noted, the analyst must assume that the forecasts in the survey are representative of the views of investors in general. This assumption seems reasonable, given that a wide range of forecasters are included in the survey and, more importantly, that many of them are large financial institutions that advise investors and trade on their own account. Nonetheless, the representativeness of the sample can be questioned. The timing of the forecasts is also important. We tried to ensure that the bond yield series was synchronized with the forecasts so that we were not comparing bond yields with out-of-date forecasts or with forecasts that contained information not available to investors at the time, but the possibility remains that the forecasts submitted to *Blue Chip* by the economists were occasionally out of date. Overall, although we recognize the potential problems of representativeness and timing, we believe that their impact was small enough not to distort our conclusions.[3]

Using survey data is not the only way to examine the constituent parts of bond yields. Two other approaches are possible: First, market data can be used. If index-linked bonds are widely available, comparison of the nominal and the real term structures will provide an estimate of investors' real interest rate and inflation expectations.[4] Second, researchers can impose assumptions that simplify the decomposition. For example, the pure expectations hypothesis implies that the risk premiums are zero or constant; the Fisher (1970) hypothesis implies that real interest rates are constant. Mishkin

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(1981, 1990) used the rational expectations hypothesis to split nominal yields into an expected inflation component and a real interest rate component.[5] This type of analysis reveals little about the empirical behavior of the constituent parts of bond yields, however, because the results hinge on the validity of the key assumptions. Campbell and Ammer (1993) used weaker assumptions—a particular specification of an econometric model known as "vector autoregression"—to examine bond market fluctuations as a combination of changes in expectations of future inflation, expectations of real interest rates, and future (required) excess bond returns. In the following sections, where relevant, we compare our results from the survey data with those of Campbell and Ammer and other researchers.

Decomposition of Bond Yields

Our main sample starts in March 1983, the first month in which the *Blue Chip* survey contained 10-year forecasts of U.S. consumer price inflation and three-month T-bill rates. We took the mean of the economists' forecasts as our proxy for investor expectations. The series consists of semiannual observations, in March and October each year, with the last observation in October 1997. For bond yields, we used the Salomon Brothers' "on-the-run" 10-year Treasury note series. The *Blue Chip* survey is published on the 10th of the month; we used yields from the last working day of the previous month because we assumed that forecasts included in the survey are likely to have been finalized about that time.

Using the *Blue Chip* long-term inflation and T-bill rate forecasts, we decomposed the series of 10-year bond yields into three parts: expectations of future inflation, expectations of real short-term interest rates, and the bond risk premium:

$$YLD_{10,t} \approx E_t(INF_{10}) + E_t(RTBILL_{10}) + E_t(BRP_{10}), \quad (1)$$

where

$YLD_{10,t}$ = Salomon Brothers' on-the-run 10-year T-note yield on the last working day of Month $t - 1$

$E_t(INF_{10})$ = expectation at time t for CPI inflation over the next 10 years, taken from the mean forecast in the *Blue Chip* survey

$E_t(RTBILL_{10})$ = expectation at time t for average real three-month T-bill rates over the next 10 years; calculated by subtracting the *Blue Chip* mean inflation forecast from the mean forecast for nominal three-month T-bill rates—that is, $E_t(TBILL_{10}) - E_t(INF_{10})$

$E_t(BRP_{10})$ = bond risk premium at time t, or the 10-year bond's expected excess return over a sequence of nominally risk-free short-term bonds; calculated as a residual—that is, $YLD_{10,t} - E_t(TBILL_{10})$

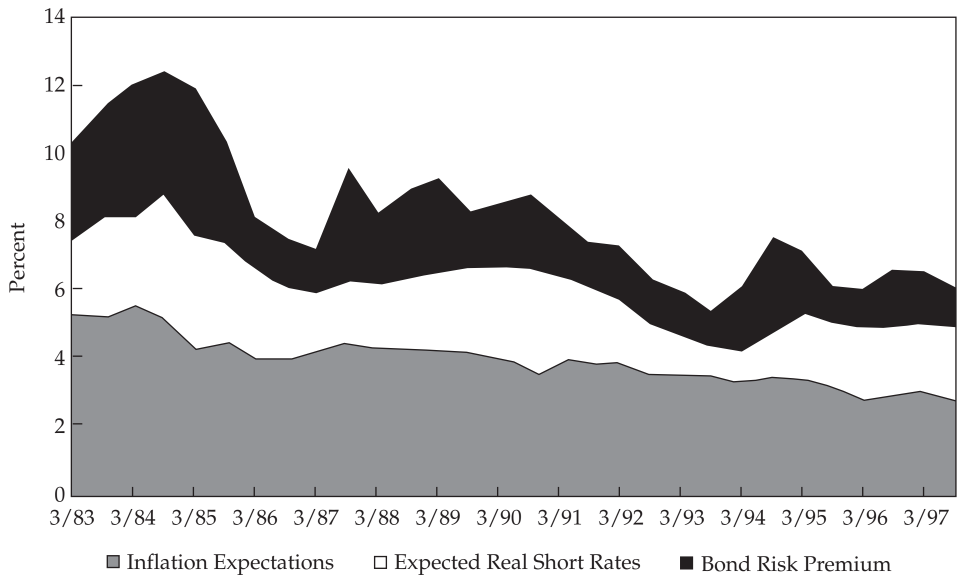
The decomposition is very general because it holds as a dynamic accounting identity and requires assuming only internally consistent expectations.[6]

For our study period, long-term U.S. bond yields generally trended down and all three components contributed to this trend. Figure 1 shows the U.S. 10-year bond yield from March 1983 to October 1997 broken down into the three constituent parts. Table 1 summarizes the data. The downward trend of yields for the whole period was interrupted only by a few short periods in which yields were rising—1984, 1987, and 1994. Declines in all three components contributed to the fall in yields. If the yield trend is measured by the difference between the latest five-year subperiod average and the first five-year subperiod average, yields have fallen by 3.67 percent. The fall in inflation expectations of 1.44 percent has made the largest contribution, followed by the 1.24 percent decline in the bond risk premium and the 0.98 percent reduction in expected real short-term interest rates.

Short-term fluctuations in 10-year bond yields appear to reflect primarily changes in the bond risk premium. The annualized basis point (bp) volatility of the bond risk premium series, based on 29 six-monthly changes, is almost as high as that of the 10-year yield series: 109 bps versus 136 bps. The expected real interest rate and inflation series are much less volatile: 52 bps and 36 bps, respectively. Because the bond risk premium is derived as the difference between the market yield and the survey forecast, however, the volatility of this component is probably more affected by measurement error than is the volatility of the other two components.

The correlations between the three components are generally low and, given just 30 observations, statistically insignificant. The estimated correlation is largest, at 0.27, between changes in expected inflation and the bond risk premium. This positive relationship is intuitive, but it stands in contrast to Campbell and Ammer's finding of a negative relationship, which we suspect is peculiar to their model specification. Most market practitioners would not believe that an increase in inflation expectations tends to coincide with a fall in the required bond risk premium. The estimated correlation between expected real short rates and the bond risk premium

Figure 1. Decomposition of U.S. 10-Year Bond Yields, March 1983–October 1997



is 0.08, whereas that between expected real short rates and expected inflation is –0.14.[7]

Expected Inflation

Inflation expectations are mean reverting. Figure 2 begins in 1979 with one-year-ahead CPI inflation forecasts taken from the Livingston survey and an extended series of long-term forecasts using GDP deflator forecasts for 1979 through 1982.[8] The graph shows that long-run inflation expectations peaked at slightly above 8 percent in 1980 and that this peak was followed by a nearly continuous decline; the largest uptick was only 0.5 percent in 1987. The figure clearly shows the mean reversion in inflation expectations. In particular, when actual year-on-year inflation was relatively high in 1980, one-year-ahead inflation forecasts also rose but they remained below the actual inflation rate and long-term inflation expectations were even lower. Conversely, when actual inflation was low in the mid-1980s and mid-1990s, one-year-ahead inflation forecasts declined but they were higher than actual inflation and long-term inflation expectations were again higher.

Since 1983, both the one-year-ahead and the long-term inflation forecasts have exceeded the realized average inflation rate of 3.5 percent by about 0.5 percent. Most of this upward bias in expectations occurred in the 1980s. The experience of the 1980s, when inflation was consistently overestimated, is easier to understand in light of the experience of the previous two decades, when inflation was consistently underestimated.

A comparison of actual and expected U.S. inflation highlights economists' forecast errors. Figure 3, which is based on the Livingston survey one-year-ahead inflation forecasts for a long period, compares inflation forecasts at each point in time with the actual outcome for the period. The graph makes clear that the inflation forecasts failed to keep up with the ever-rising pattern of inflation in the 1960s and 1970s.[9] De Bondt and Bange (1992) analyzed the structure of forecast errors in the Livingston data and concluded that the inflation forecasts were "insufficiently adaptive"; that is, they

Table 1. Decomposition of U.S. 10-Year Yields, 1983–97

	10-Year Yield	Inflation Expectations	Expected Real Short Rates	Bond Risk Premium
Average: 1983–97	8.19%	4.00%	2.18%	2.01%
Subperiod 1: 1983–87	10.07	4.69	2.65	2.73
Subperiod 2: 1988–92	8.11	4.07	2.22	1.82
Subperiod 3: 1993–97	6.40	3.25	1.67	1.49
Latest: October 1997	6.11	2.85	2.15	1.11

Figure 2. U.S. Inflation Expectations and Actual Inflation, March 1979–October 1997

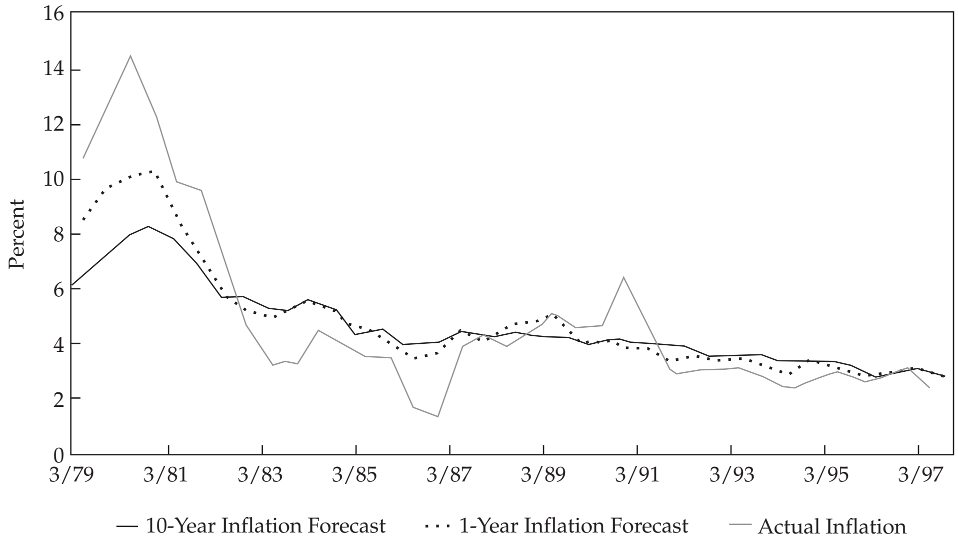
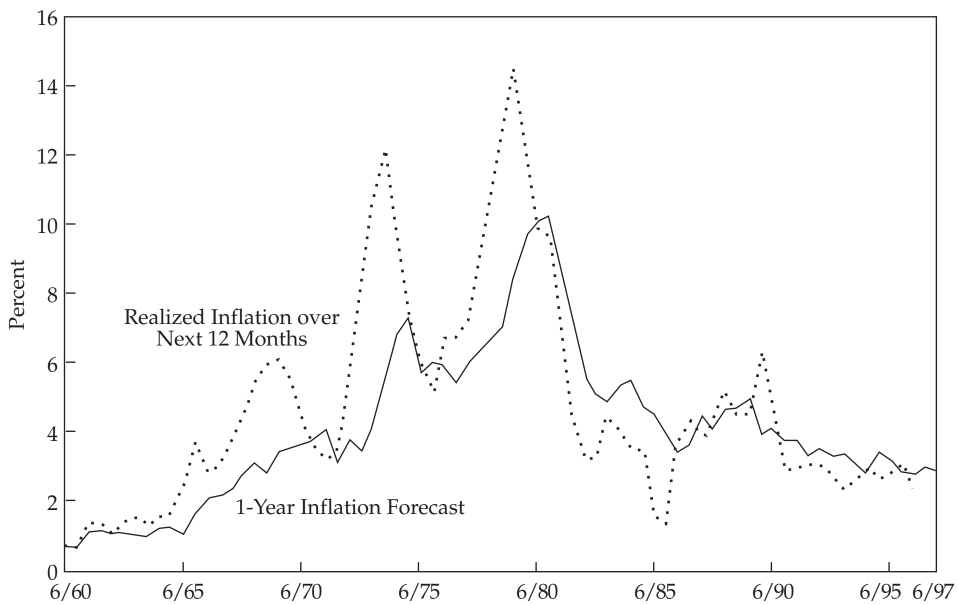


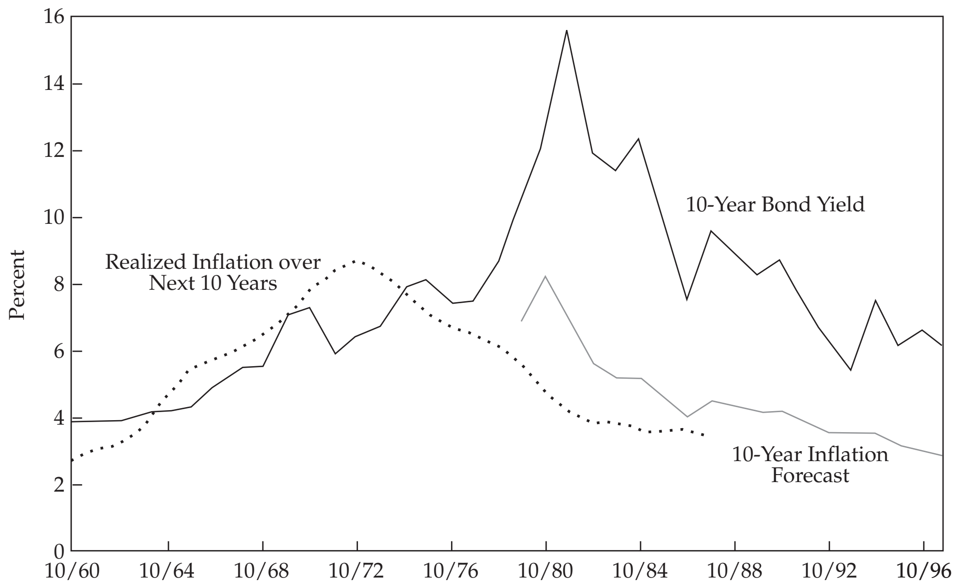
Figure 3. Actual and Expected U.S. Inflation, June 1960–June 1997



gave too much weight to inflation in the distant past relative to recent inflation and, as a result, rose too slowly when inflation accelerated and declined too slowly when inflation fell.[10]

The inflation forecasts implicit in bond yields also underestimated inflation in the 1960s and 1970s and overestimated it in the 1980s. As Figure 4 shows, for many years, the realized real returns on 10-year bonds were negative because of unexpected inflation. Economists' overly high inflation forecasts in the 1980s and the resulting unexpectedly high realized real yields can be viewed from this perspective as a natural continuation of the errors from the 1960s and 1970s. Painful past forecast errors probably made bond investors and economists in the early 1980s excessively pessimistic about the inflation outlook: Once bitten, twice shy. Of course, the subsequent gradual revision of those pessimistic views gave rise to the strong performance of the U.S. bond market during the 1980s and 1990s.

Figure 4. U.S. 10-Year Bond Yields and 10-Year (Forecasted and Actual) Inflation, October 1960–October 1997



Expected Real Interest Rates

Real interest rate expectations appear to be procyclical. Figure 5 plots long-term and short-term forecasts of average real three-month T-bill rates. We calculated the long-term series by subtracting the *Blue Chip* 10-year inflation forecast from the 10-year forecast for average three-month T-bill rates. The long-term series has been trending down but in a less regular fashion than inflation expectations. Peaks in the series occurred in 1984 and 1990, and troughs in 1986 and 1993.

The high expected real interest rates in the early 1980s were apparently at least partially a reaction to the opposite experience of low *ex ante* real interest rates in the 1970s and even lower *ex post* rates. The downtrend of the past 15 years has coincided with a trend decline in inflation expectations and in the bond risk premium. When *changes* in the series are examined, however, the link is weaker and the correlation quite low.

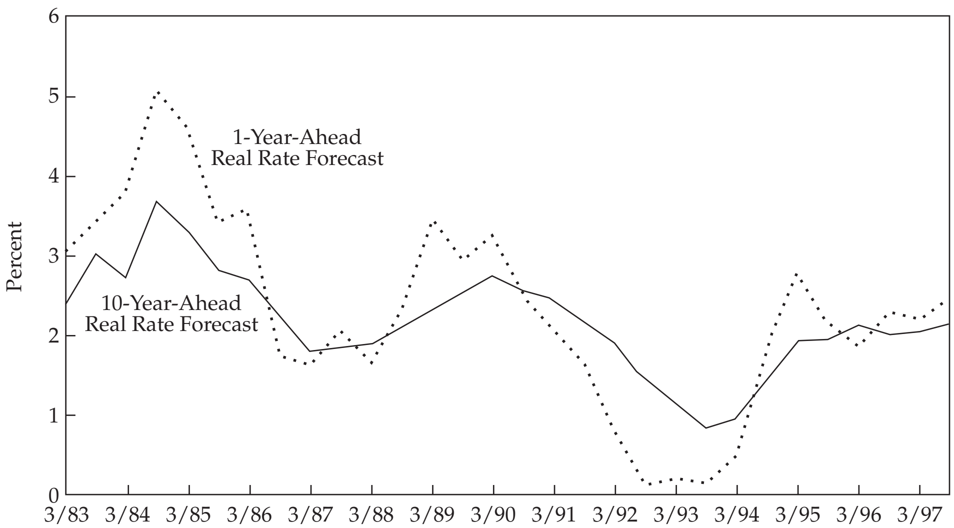
The narrow range of peaks and valleys from 1 percent to 4 percent is consistent with the widely held view that expected real short rates vary around a relatively constant long-term mean. The mean level may change because of demographic and productivity trends and with the development of financial institutions, but any change is likely to be slow.

Figure 5 also shows the series for the one-year forward forecast of real short-term interest rates. This series is calculated by subtracting the one-year consensus inflation forecast from the consensus expectation for three-month T-bill rates for the following year. Figure 5 shows that long-term expectations are pulled up and down by fluctuations in short-term expectations.

Various economic theories link fluctuations in real interest rates to the business cycle (see, for example, Barro and Sala-i-Martin 1990 and Cunningham and Cunningham 1990). Variations in the marginal rate of substitution between current and future consumption, or more simply, consumption smoothing, *could* cause a countercyclical pattern in real interest rates. During recessions, investors reduce the amount they save from their income, which limits the supply of capital. Loan demand, however, is probably also lower, so the net effect on real interest rates is difficult to predict. On the other hand, monetary policy is likely to reinforce a procyclical pattern in real interest rates because it usually involves lowering nominal and real short rates during a recession to revive the economy and raising rates at the mature stage of expansion to avoid higher inflation.

Statistically, our survey evidence is consistent with a procyclical pattern in real interest rate expectations: The correlation between changes in successive consensus GDP growth forecasts and one-year-ahead real interest rate expectations is 0.30. Uptrends in Figure 5 reflect the strong economic growth and the Federal Reserve's tightening of monetary policy in 1984, the 1988–89 period, and 1994, which pushed up short-run and, to a lesser extent, long-run real interest rate expectations. Similarly, the Fed's easing of policy from 1991 to 1993,

Figure 5. Long-Term and Short-Term Forecasts of Real U.S. Interest Rates, March 1983–October 1997



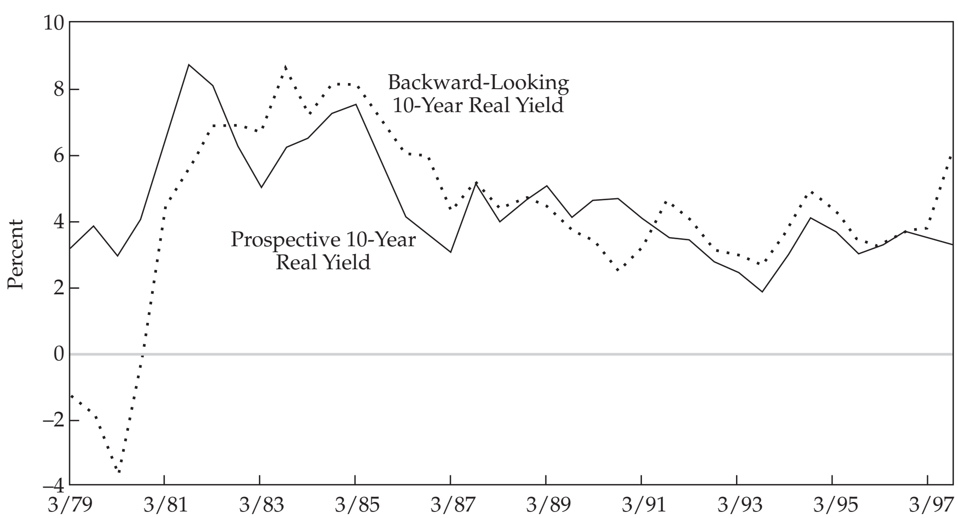
which was begun to revive economic growth and extended to support the troubled banking sector, pulled short-term real interest rates down to zero and also reduced the expected long-term average to a historical low of 1 percent.

Prospective real yields are better than backward-looking measures. Turn the focus now from short-term real interest rates to real yields on the 10-year bond. Figure 6 contains a plot of the prospective real bond yield—measured by the difference between the nominal 10-year yield and the 10-year inflation forecast—and the commonly used backward-looking real bond yield, in which the past year's inflation proxies for expected inflation. Investors and financial analysts should note that the two series sometimes give significantly different messages. The backward-looking real yield measure was especially misleading in the 1979–80 period, but the difference was 2 percent even in 1990, when actual inflation was 6 percent but was forecasted to fall to 4 percent the following year.

Bond Risk Premium

The U.S. 10-year bond risk premium we calculated has recently been at the low end of the 1 percent to

Figure 6. Prospective and Backward-Looking Real Yield on U.S. 10-Year Bond, March 1979–October 1997

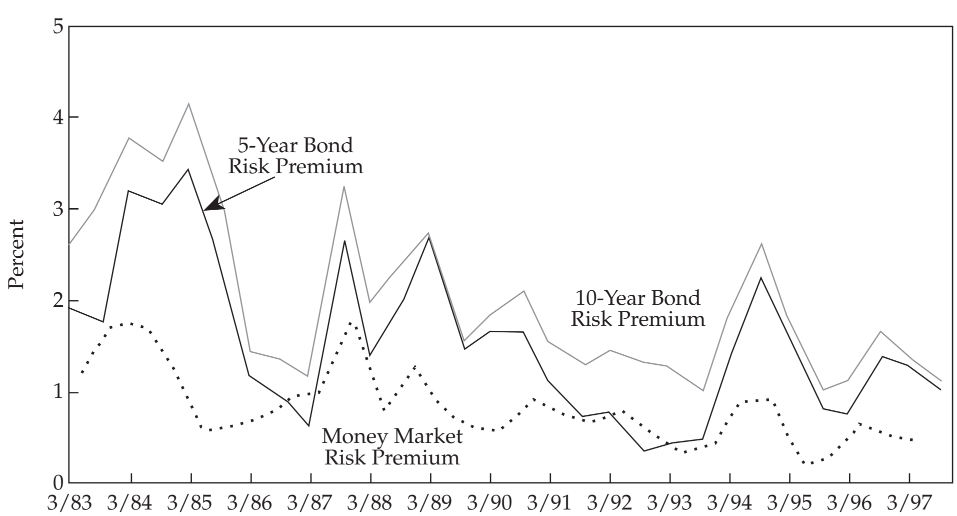


4 percent range. We calculated the bond risk premium as the expected return on the 10-year bond in excess of the return on the three-month T-bill, on average, over the life of the bond. Figure 7 shows the risk premium range, together with the five-year bond risk premium and the six-month money market risk premium.[11] The range for the 10-year bond is consistent with many market participants' intuition, but this intuition could never before be confirmed with empirical estimates. Empirical forecasting models could give estimates of the bond's *near-term* expected excess return, and survey data could provide risk premium estimates for short-term money market instruments, but unlike our measure, neither approach could give a direct estimate of the 10-year bond's expected return advantage over a sequence of short-term bonds.

Our estimate of the 10-year bond risk premium may appear high to readers familiar with long-term evidence of very low historical excess returns for bonds (see Ibbotson 1997 and Wilson and Jones 1997). Remember, however, that we examined a relatively short period and most of it was after the peak of inflation in the early 1980s.[12] The required risk premium appears to have peaked in the early 1980s, probably reflecting the past experience of high and volatile inflation and yield levels. Although we could not estimate the bond risk premium before 1983, nominal and real bond yields imply that the premiums were much lower, probably less than 1 percent, before the 1970s than during our study sample.

Survey measures of the bond risk premium are important for market participants and financial analysts because historical average bond returns have almost no information about long-run future bond returns or about normal risk premiums. The main

Figure 7. Survey Risk Premiums in the U.S. Bond and Money Markets, March 1983–October 1997



reason for this lack of information, as Bernstein (1997) argued, is that even long histories of bond returns are driven by persistent unexpected inflation trends—recall Figure 4—rather than by equilibrium expectations.[13]

Figure 7 shows that the assumption of a constant bond risk premium is unreasonable. The fluctuations in our series appear too large to be explained by measurement errors. Moreover, the risk premiums for five-year bonds and six-month money market instruments, again using the Salomon yield series, reveal patterns similar to that of the 10-year series. Finally, the fluctuations make economic sense, as we will discuss.

The downward trend in the required risk premium in the past 15 years reflects both *less risk* in nominal bonds—the level and volatility of inflation and yields have declined—and a generally *lower market price of risk*—implied by higher equity market valuations and narrower credit spreads. Notably, the estimated bond risk premium exhibits strong yield-level dependency, a feature that is qualitatively consistent with the Cox–Ingersoll–Ross (1985) model in which the risk premium varies only with yield volatility and yield volatility varies with yield level.

An economic rationale may be possible for the fluctuations in the bond risk premium. The peaks in Figure 7 coincide with either periods of tightening monetary policy and consequent weakness in the U.S. bond market—1984, the 1988–89 period, and 1994—or with recessionary environments, when investor pessimism may have led to undervaluation of long-term assets—1982, 1990, and 1987 following the October stock market crash. The troughs, especially those in 1986 and in the 1991–93 period, coincide with periods of easing monetary policy and strong bond market performance.

Our analysis suggests that time variation in the bond risk premium may be useful as a market-timing signal. The correlation between the survey-based bond risk premium and the subsequent six months' realized excess bond return is 0.39. (The predictive correlation of the nominal bond yield is 0.29.) Moreover, the average realized return advantage of bonds over bills is much higher following a time of above-average bond risk premiums than following a time of below-average bond risk premiums: The annualized excess returns for the two subsamples are 5 percent and 0 percent, respectively.[14]

Conclusions

Data from surveys of economists' forecasts can be used to decompose long-term yields into three parts: expected inflation, expected real short-term interest rates, and the required bond risk premium. All three components have contributed to the decline trend in yields in the past one and a half decades. Moreover, we can show that fluctuations in the series over time have a plausible economic rationale. Our approach of using long-term consensus forecasts provides analysts with better information about the bond market than does studying realized returns or assuming constant relationships in the structure of yields.

Notes

1. *Blue Chip* began surveying long-term forecasts, including forecasts of the GDP deflator, in March 1979. It was not until March 1983, however, that inflation (as indicated by the U.S. Consumer Price Index [CPI]) and three-month T-bill rates were included.
2. In the pure expectations theory of the term structure, long-term yields are equal to investors' expectations of future short-term interest rates and the risk premium is zero. Previous research (for example, Shiller, Campbell, and Schoenholtz 1983 and Fama and Bliss 1987) rejected the pure expectations hypothesis, possibly in favor of a time-varying risk premium. Our analysis is consistent with a time-varying bond risk premium.
3. Simple robustness checks support this assumption. First, the long-term inflation forecasts from the *Blue Chip* survey were always within 0.5 percent of the equivalent forecasts in the University of Michigan survey, which suggests that *Blue Chip* forecasts are representative. Second, our results were similar whether we used yields from the survey date or the previous month end, which suggests that precise timing is not a major issue.
4. Such data are beginning to be available in the United States with the introduction of CPI-linked bonds (and have been available in the United Kingdom since the early 1930s). Even this approach requires assumptions, however—specifically, zero or negligible inflation risk premiums and the absence of tax, liquidity, and convexity effects.
5. The rational expectations hypothesis implies that forecast errors are zero on average. Rather conveniently, if perhaps unrealistically, with this hypothesis, researchers can use realized future rates as a proxy for market expectations.
6. We explain the generality of this decomposition as follows: (1) A long bond's yield is, given the known maturity value, an average of the bond's realized future one-period returns. (2) These realized future one-period returns can be split into (a) the return of the nominally risk-free one-period asset and (b) the excess return of the long bond over the nominal one-period rate. (3) Part *a* can be further split into realized inflation and the realized real return of a nominal one-period asset. (4) Thus, today's long yield can be viewed as a sum of future *realized* inflation, real short rates, and excess bond returns. As long as expectations are internally consistent, however, a similar three-part decomposition must hold in expectations also, which is what is shown in Equation 1.

The equality in Equation 1 is approximate because it ignores the value of convexity and the difference between coupon-bond and zero-coupon-bond yields. Convexity refers to the nonlinearity in a bond's price–yield relationship that tends to reduce long-term yields. For a 10-year bond, however, the convexity's impact on yields is only a few basis points—and thus negligible in our yield decomposition (see Ilmanen 1995a, 1995b). On-the-run bonds that we used have coupons close to the yield level, whereas the decomposition described in the first paragraph of this note applies to zero-coupon-bond yields. The difference between these two yields (par yields versus spot yields) depends on the curve steepness; during the 1983–97 period, 10-year spot yields were 0–25 basis points higher than the 10-year par yields. Fortunately, the impacts of convexity and of the par versus spot yield discrepancy have different signs and tend to offset.

7. Many previous studies have also found a negative relationship between expected inflation and the expected real interest rate (see Campbell and Ammer; Fama 1990; Mishkin 1981, 1990; and Pennacchi 1991).
8. The Livingston survey is a long-standing survey of economic forecasts initially conducted by Joseph Livingston of the *Philadelphia Inquirer* newspaper and taken over by the Philadelphia Federal Reserve Bank in 1990.
9. These systematic forecast errors are more understandable in light of the fact that U.S. inflation had not been persistent until the 1950s but that, after that time, inflation kept reaching new record levels. Thus, the reasonable expectation *ex ante* was that inflation would revert to its historically near-zero level. *Ex post*, analysts know that inflation shocks became increasingly persistent in this period.
10. Our analysis focuses on understanding the impact of inflation expectations on bond yields rather than judging the accuracy or rationality of these forecasts. De Bondt and Bange and Keane and Runkle (1990) provided interesting analyses of forecasting abilities.
11. The five-year bond risk premium was calculated by subtracting *Blue Chip* five-year-ahead short rate forecast from the five-year yield. The money market risk premium is the difference between the six-month rate six months forward and the *Wall Street Journal*'s survey consensus forecast of the six-month T-bill rate in six months' time. (The *WSJ* survey is conducted each June and December.) This risk premium is naturally smaller than the bond risk premiums in Figure 7 because it corresponds to the expected compensation for a six-month-duration extension, whereas the risk premiums on the 5- and 10-year bonds correspond to the expected return advantage for duration extensions of roughly 4 and 7 years, respectively.
12. In fact, the *realized* annual excess return of the 10-year bond over three-month rates has exceeded 4 percent in the 15-year period we studied—clearly more than the 2 percent average *expected* excess return. The remainder reflects capital gains from the unexpected decline in yields.
13. It is perhaps ironic that although analysts can know almost exactly the expected return of a 10-year bond over the next 10 years—that is, close to its market yield—they know very little about either the bond's near-term return (because future realized returns are dominated by unexpected news) or about the expected return of a sequence of 10-year bonds far into the future (because even past realized returns are dominated by unexpected news, not by expectations).
14. For more detail on tactical asset allocation and forecasting asset returns, see Best and Byrne (1997) and Ilmanen (1997).

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