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**IMPLICATIONS OF RETURNS ON
TREASURY INFLATION-INDEXED SECURITIES FOR
PROJECTIONS OF THE LONG-TERM REAL INTEREST RATE**

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Abstract:

This paper updates and extends previous work which considers the real interest rate on the Social Security Trust Fund. The paper adds 2005 data to the previous extensive historical series, and the resulting average long-term government real interest rate back through 1870 is just under 3 percent. Over the last 40 years or so, the Trust Fund rate has been about 24 basis points below the long-term government rate. The paper then extends previous work by using yield curves for Treasury inflation-indexed securities (TIPS) to develop forward-looking market projections for the real return on a hypothetical trust fund made up of TIPS. The comparable average real return on the hypothetical trust fund is roughly estimated to be around 2-3/4 percent.

The author is with the U.S. Department of the Treasury. The views expressed here are those of the author and not necessarily those of the Treasury Department. I would like to thank Mark Warshawsky, Nada Eissa, Karen Hendershot, Ralph Monaco, and James Duggan for their helpful suggestions.

Introduction

Previous work¹ has examined the long-term real interest rate on the Social Security Trust Funds. That work included the analysis of historical interest rate data and the examination of yield curve estimates of long-term returns implied in the market for Treasury inflation-indexed securities (TIPS).

The historical analysis was needed because the actual Social Security nominal interest rate is not available before the end of September 1960. This gives only about 40 years of data, which is a relatively short time period to calculate a historical average. Therefore, the previous work developed a historical real interest rate back through 1870 based on a historical nominal interest rate series that is similar to the Social Security interest rate and an equivalent price series based on the CPI-W. In the first section, this paper presents these series through 2005.

However, historical data are, by definition, backward looking, and do not incorporate expectations for the future. Therefore, the paper moves on to TIPS to ascertain market expectations for future real interest rates.

The second section of the paper sets out the updated TIPS yield curves through 2005. The third section uses the curves to construct returns on a hypothetical Social Security trust fund made up of TIPS. The fourth section draws on the yield curves to estimate the long-run expected returns for the hypothetical trust fund and the actual Social Security Trust Fund.

Historical Series

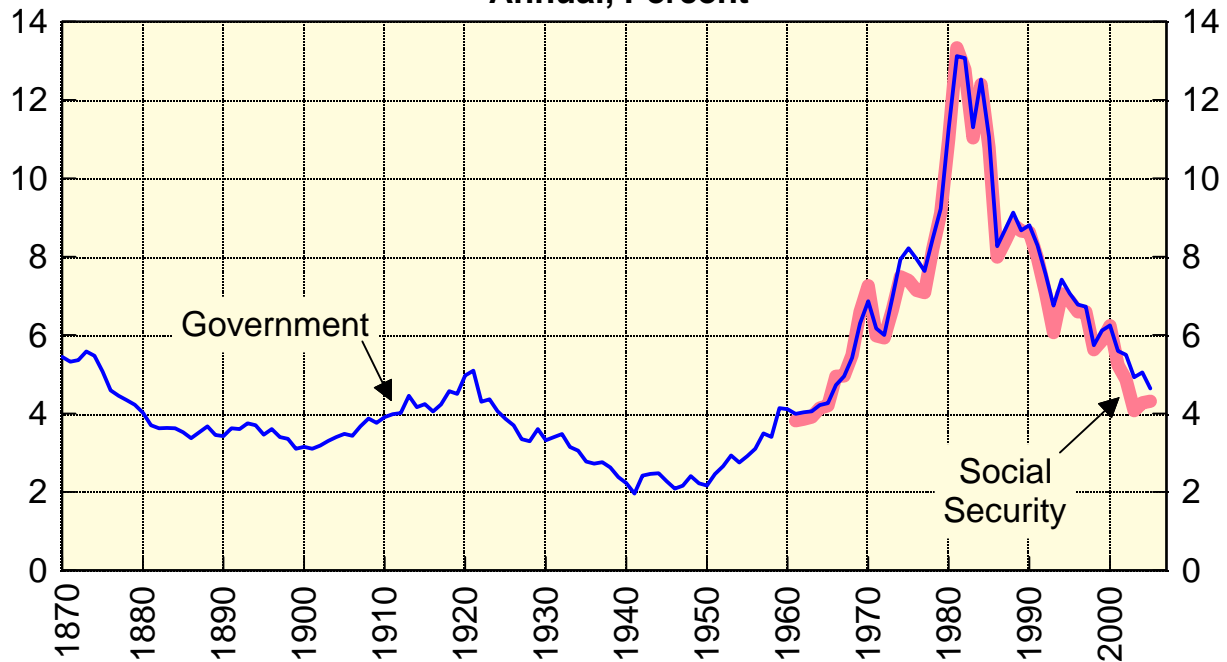
The previous paper Girola (2005) presented a historical government nominal interest rate, a historical price series based on the CPI-W as adjusted by Social Security for methodological improvements, and the resulting historical government real interest rate. The data sources for these series are cited in the previous paper, and the series are here updated for 2005.

The government nominal interest rate series is updated by the Ibbotson data on long-term Treasury bonds for 2005.² Chart 1 plots this rate annually back through 1870 and includes the updated annual average of the Social Security Trust Fund interest rate back through 1961.

¹ See Girola (2005).

² See Ibbotson Associates (2006).

CHART 1: INTEREST RATES
Annual, Percent



The chart shows that the government rate tracks the Social Security rate closely. Because the Ibbotson data in the government rate are for a 20-year bond while the Social Security rate is an average over a range of maturities as low as 4 years, the former can typically be expected to be higher than the latter. This is borne out by the fact that the average spread between the two for 1961-2005 is 24 basis points. The government nominal interest rate fell from 5.04 percent in 2004 to 4.64 percent in 2005, whereas the Social Security rate rose from 4.27 percent to 4.31 percent, reflecting the flattening of the Treasury yield curve last year.

Charts 2 and 3 show the annual average of the CPI-W through 2005. Annual average inflation accelerated from 2.6 percent in 2004 to 3.5 percent in 2005.

CHART 2: ADJUSTED CPI-W
Annual Level, Ratio Scale

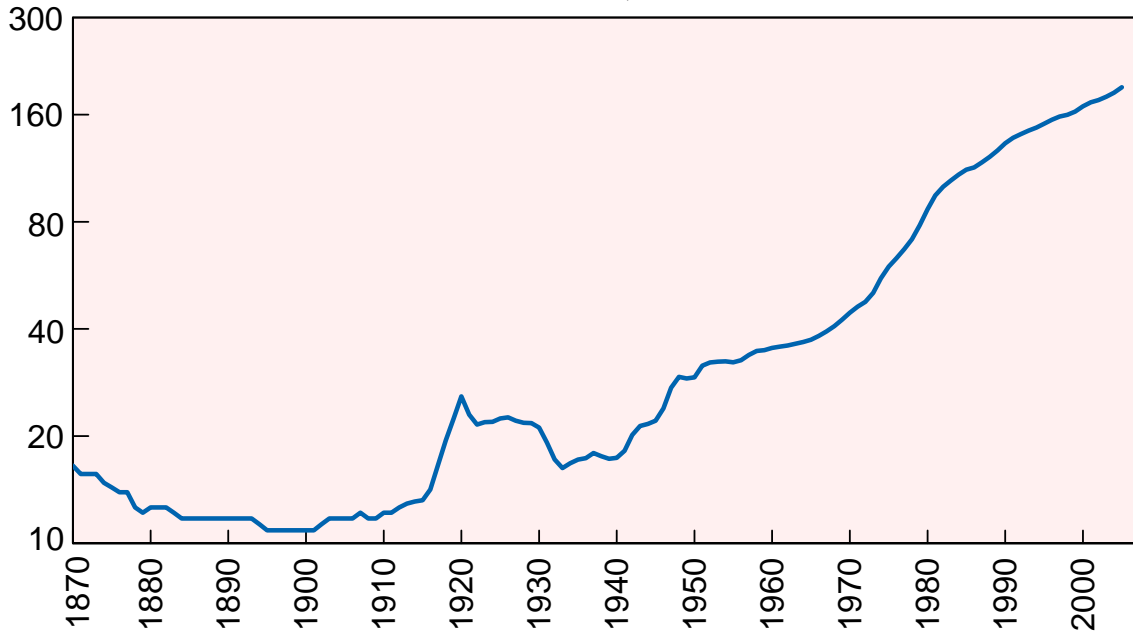
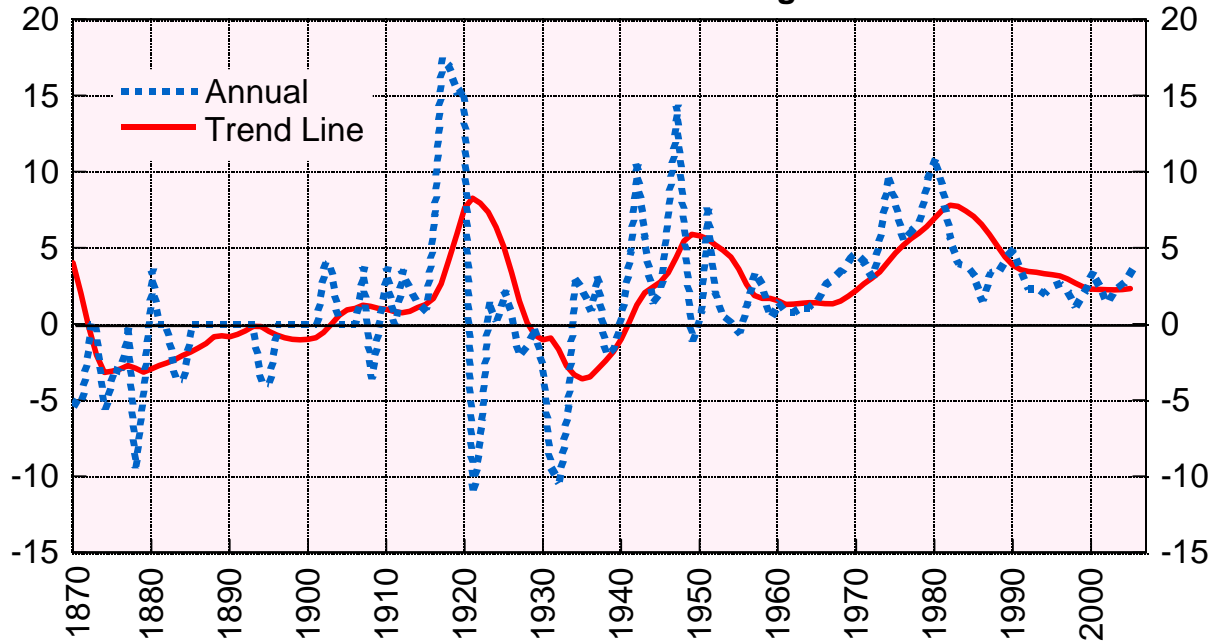
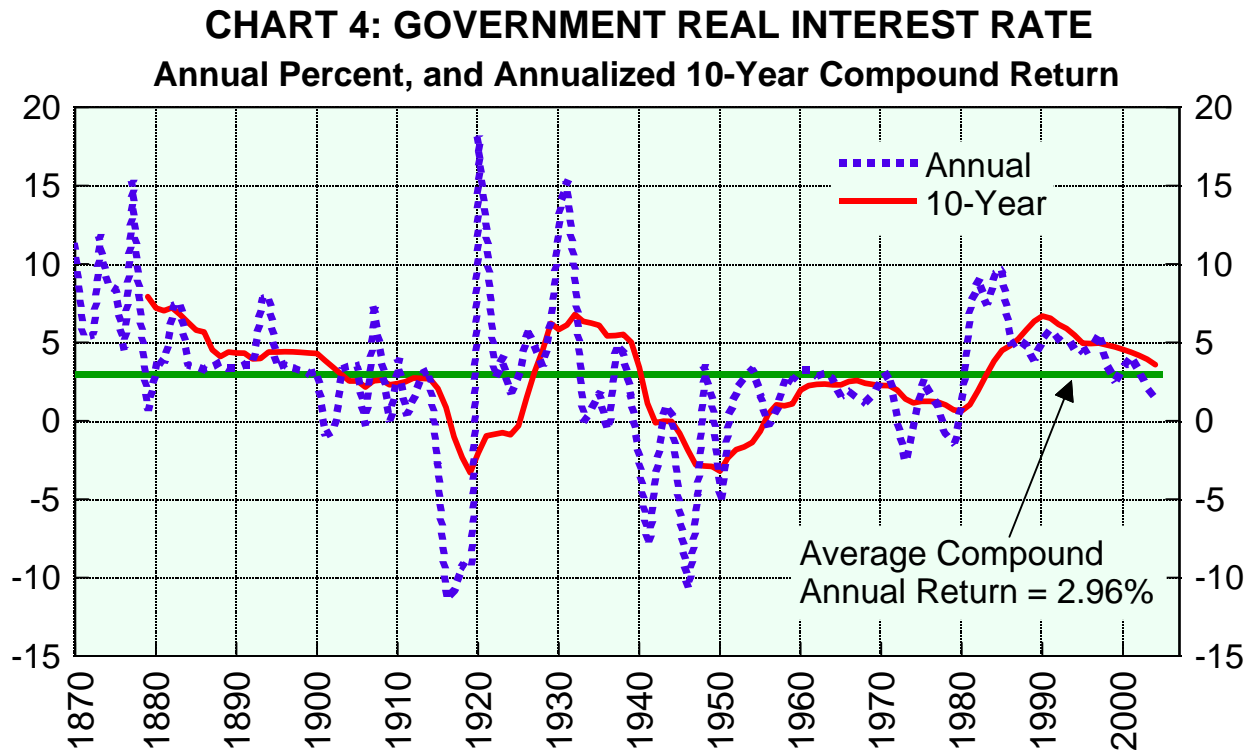


CHART 3: ADJUSTED CPI-W
Annual Percent Change and
Annualized Trend-Line Percent Change over 10 Years



The government nominal interest rate and the price series are put together in Chart 4 to get the real return as computed by the Social Security formula. The real return series stops in 2004 because the calculation requires the CPI-W for the year ahead and 2005 is the last year for which the CPI-W is available.³



The long-term average compound government real interest rate over the entire period 1870-2004 is 2.96 percent. For the years 1961-2004, the average government real interest rate is 3.44 percent, compared with 3.20 percent for the average compound real Social Security rate; the difference is 24 basis points, the same as the average difference between the two nominal rates in Chart 1. For 2004 the government real interest rate is 1.53 percent and the real Social Security rate is 0.77 percent, compared with 2003 values of 2.29 percent and 1.44 percent, respectively.⁴

³ The Social Security formula for computing real return uses the average nominal interest rate for each year and the price indexes for that year and the following year. The formula first calculates the semiannually compounded nominal return from a bond bought at par with that interest rate and then sold at par, where it is assumed that this bond pays a coupon of half the interest rate at midyear which is reinvested at the same rate, and another coupon at the end of the year. The real return is then obtained by dividing the nominal return by the ratio of next year's price to the current year's price. For more information, see Girola (2005), p. 7.

⁴ Calculations including 2004 are done by the author. See the Trustees Report (2005) for more information on Social Security interest rates.

The TIPS Yield Curve

The following sections of the paper focus on the market for Treasury inflation-indexed securities (TIPS) and examine what this market has to say about the long-term Social Security interest rate.

TIPS are important for the Social Security interest rate because the TIPS market can reveal market expectations for long-term real interest rates. Consequently, analysis of the TIPS market is forward looking, in that such analysis concentrates on expected future economic conditions. In contrast, historical data as presented in the previous section are backward looking, and even though history is an important guide for the future, historical averages do not include future expectations.

Of course, market expectations may shift over time and expectations at any particular point in time may not be fulfilled. Even so, expectations which are sustained for a significant period of time can be assumed to embody information that should inform judgment about the future of interest rates.

Use of TIPS is somewhat limited by the lack of past data. TIPS were first issued in 1997, but it appears that the TIPS market did not reach maturity until about June, 2002 when Treasury renewed the commitment to TIPS in the May 2002 Quarterly Refunding Statement. As a result, there is about 3-1/2 years worth of reasonably mature TIPS data for analysis. Nevertheless, if current market expectations are the center of attention, a long record of TIPS data may not be needed.

The empirical analysis of the TIPS market done in this paper continues and deepens the yield curve approach presented in previous work. Among other features, this approach provides a projected TIPS long-term forward real interest rate which can reveal market expectations. Details of this approach are outlined in the Appendix.

For this paper, the TIPS yield curves were fitted to daily TIPS quotes for 1,678 business days from April 15, 1999 through the last business day of 2005 which was December 30, 2005.⁵ Chart 5 depicts the spot rates from all the yield curves and includes projections out to 80 years maturity. At the short end, spot rates have been moving up along with Federal Reserve increases in the federal funds rate target. Moreover, the curve has flattened out recently.

⁵ In this paper, TIPS quotes were provided by Treasury's Office of Debt Management. The yield curves in this paper are not used to compute the inflation-indexed rates published in the Federal Reserve Board's H.15 release.

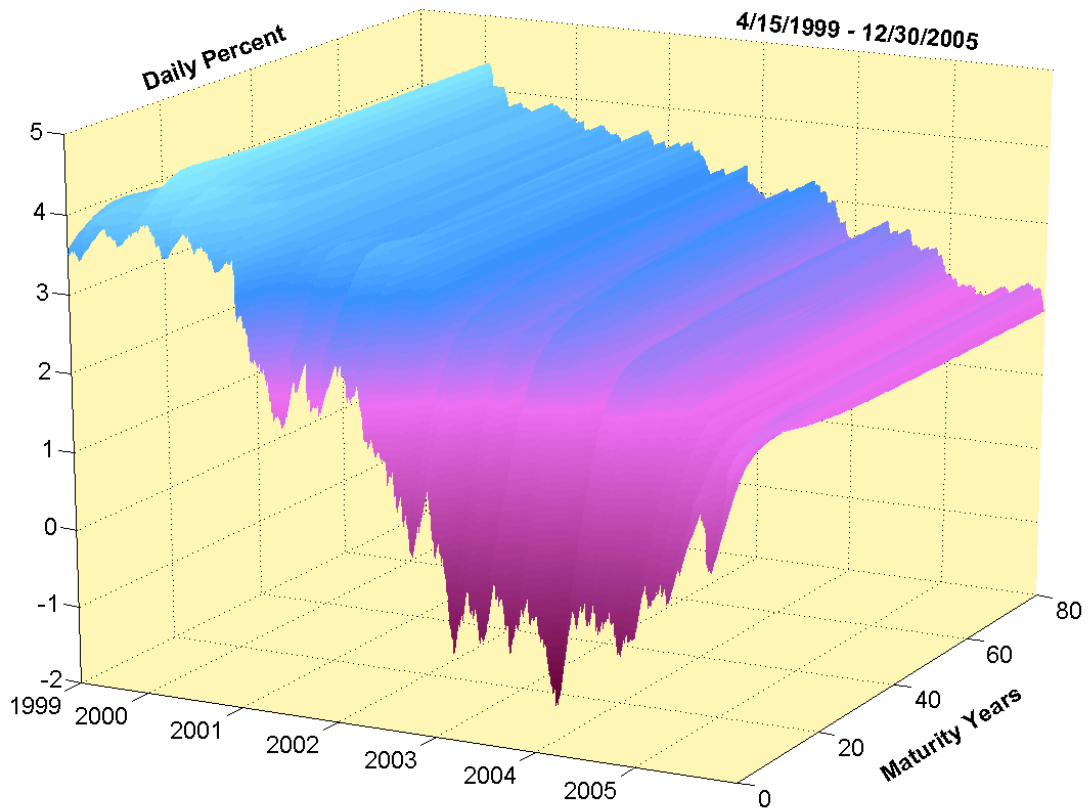
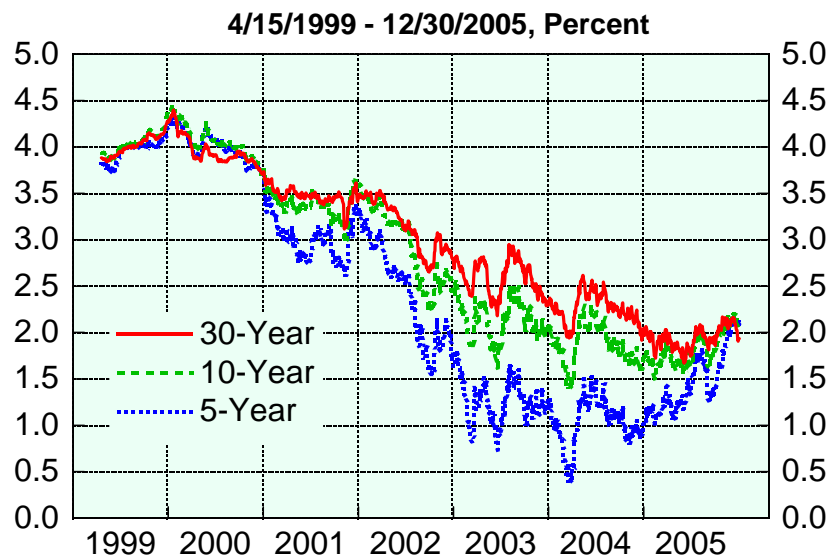
CHART 5: TIPS SPOT YIELD CURVES

Chart 6 plots daily par yields which were read off the fitted yield curves for maturities 5, 10, and 30 years. This chart shows that yields were low since mid 2002, and have stayed at 2 percent or below recently.

CHART 6: TIPS PAR YIELDS

TIPS Trust Fund Returns

The charts in the previous section depicted spot and par rates for the TIPS yield curves. In order to use the curves to project the interest rate relevant to Social Security, however, the Social Security real interest rate method must be applied. The appropriate real interest rate concept for Social Security is the real rate of return from TIPS computed analogously to the real rate of return for the Social Security Trust Funds.⁶

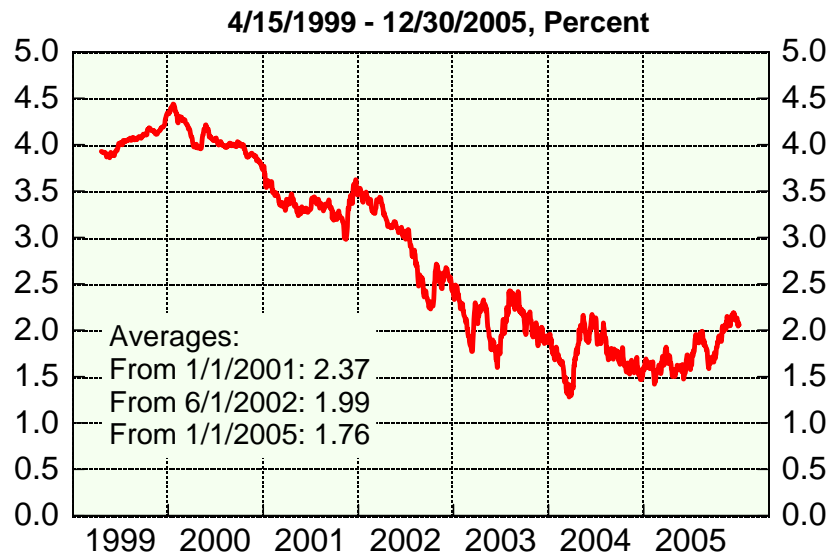
By this concept, the TIPS real return is the real return that would be produced by a trust fund made up of TIPS. Moreover, the return as so defined is an estimate of the actual Trust Fund real return (based on nominal Treasury securities) after possible adjustments, including the addition of an inflation risk premium to the TIPS return, and the subtraction from the return of adjustments for the tax treatment of TIPS and for the lower liquidity of TIPS relative to nominal Treasuries.

Chart 7 plots the daily real returns on a hypothetical Social Security trust fund made up of TIPS using the yield curves computed in the last section. For the purpose of calculating the returns, the yield curves provide estimates of what the arrays of TIPS yields would have been in the past if there had been a fully filled out TIPS market at that time. The weights applied to the TIPS yields to get the trust fund returns are the same as were actually used for the nominal Trust Fund returns.

The chart shows that returns on this simulated TIPS trust fund have averaged only about 2 percent for the 3-1/2 years through the end of 2005, and over the last year they were even lower.

⁶ Specifically, the TIPS return is the semiannually compounded market weighted average yield on TIPS, ignoring capital gains and losses.

CHART 7: TIPS TRUST FUND REAL RETURN*



* Hypothetical market-weighted TIPS trust fund return, estimated from TIPS yield curves

The charts in this and the previous section indicate that if the last several years are representative of the TIPS market into the future, TIPS returns may remain near 2 percent or below indefinitely. This could lead to a sustained period of low real returns like the one after World War II, which would continue to depress the average long-term real interest rate.

However, there are various special factors which may have temporarily pushed down real interest rates over the last several years, including the low real rates following the recession in 2001, the accommodative monetary policy which brought the federal funds rate target down to 1 percent from mid 2003 to mid 2004 followed by tightening, and an exceptionally large pool of foreign savings.

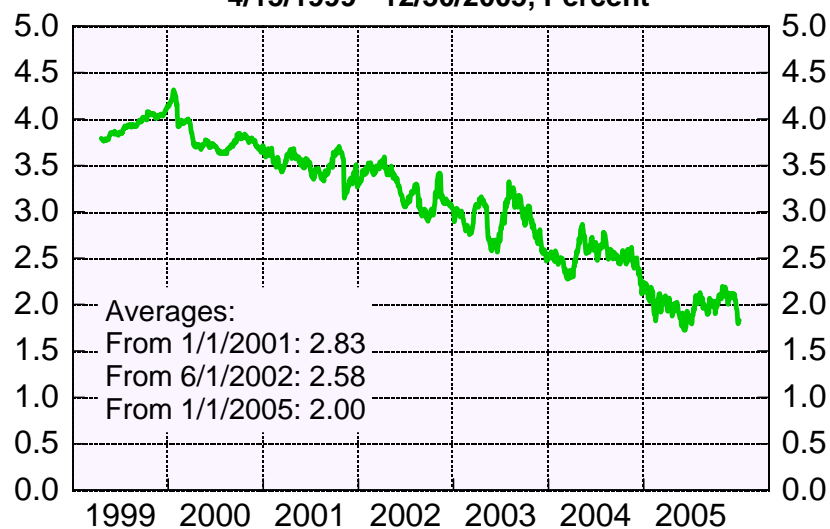
Therefore, the future levels of real returns, and whether returns will continue to be low, cannot be inferred simply from the fact that returns have been low the last several years. However, the yield curves also contain information about market expectations of future returns. Therefore, in the next section the curves are examined further to see whether the market expects the current levels of low returns to persist.

Expected TIPS Returns

The starting point for studying long-run expectations is the long-run forward rate derived from the yield curves. The forward rate is the short-term interest rate for future periods implied by the yield curve, and the long-run forward rate is the constant forward rate at longer maturities. The yield curve approach used here and in previous work produces a value for the long-run forward rate.⁷

Chart 8 plots the daily TIPS long-run forward rate from the yield curves. The chart shows that the forward rate has been declining. However, it seems to have evolved a bit more smoothly than shorter-term rates such as the TIPS returns in Chart 7. The greater smoothness suggests that the long-run forward rate may be less influenced by short-run effects such as market immaturity, and so may be more useful as a monitor of expectations.

**CHART 8:
TIPS LONG-RUN FORWARD RATE**
4/15/1999 - 12/30/2005, Percent



However, the TIPS long-run forward rate does not directly translate into long-term trust fund return expectations because it must be adjusted for term premia. Conceptually, the adjustment can be broken into two parts. First, the long-run forward rate term premium must be subtracted from the long-run forward rate to get the expected short interest rate. And second, the term premium for the TIPS trust fund return must be added back to the expected short rate to get long-term expectations for the TIPS trust fund return.

⁷ Specifically, the long-run forward rate is the average forward rate for maturities 10 through 31-1/2 years, which is held constant at higher maturities for projections. The Appendix has more details.

More concisely, the net term premium, that is, the difference between the term premium for the long-run forward rate and the term premium for the TIPS trust fund return, must be subtracted from the long-run forward rate. The net term premium is simply an adjustment factor to convert the forward rate into the expected TIPS trust fund return.

To estimate the net term premium, Chart 9 plots the hypothetical trust fund return (Chart 7) subtracted from the long-run forward rate (Chart 8):

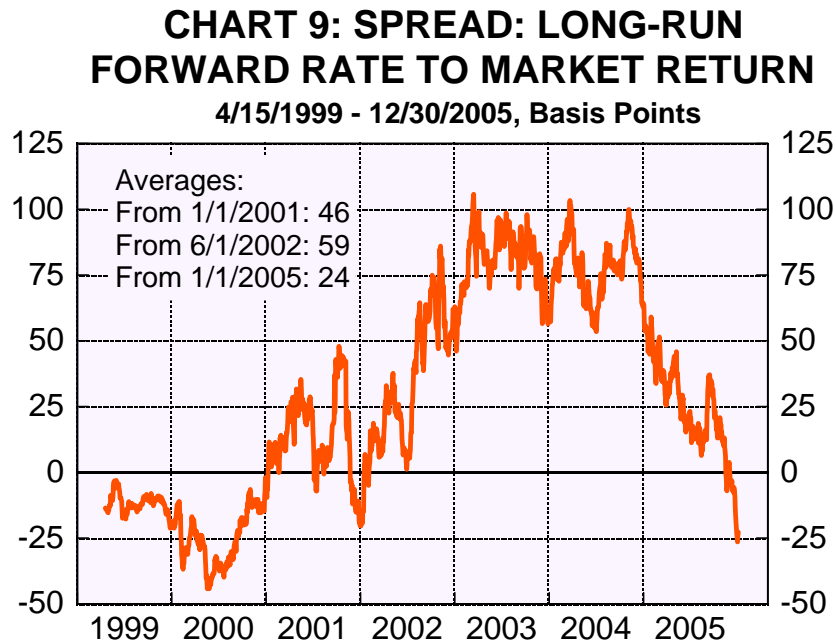


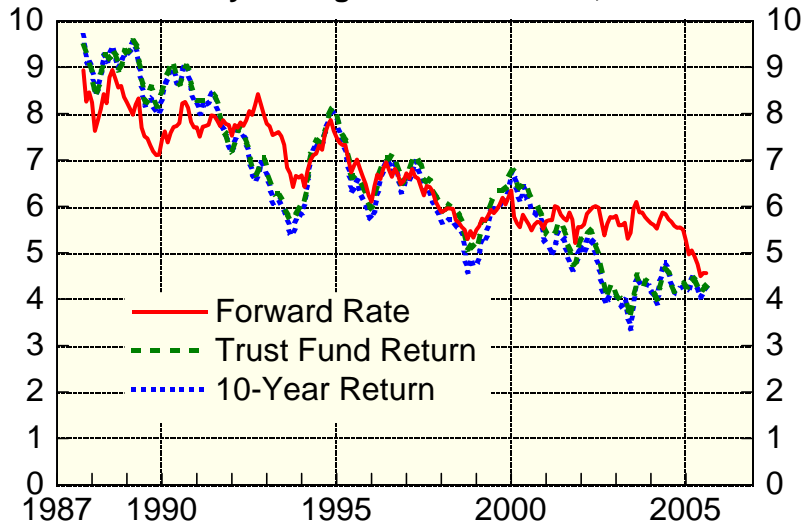
Chart 9 suggests an average net term premium of 50 basis points or more over the last several years. However, a confident estimate of the net term premium would require a much longer historical record in order to smooth out the idiosyncrasies of the various historical episodes. So estimates from the TIPS data available at this time must be seen as a work in progress.

To get another estimate of the net term premium, data from nominal Treasuries can supplement the limited historical record from TIPS. Charts 10 and 11 display data for a nominal long-run forward rate from coupon STRIPS and returns derived from the Trust Fund nominal interest rate and the 10-year Treasury constant maturity yield.⁸

⁸ The two charts end in August 2005 because data for the 30-year STRIPS series for monthly averages were not available as a result of the absence of a current 30-year Treasury bond. Recently, because of the return of the 30-year bond, this 30-year STRIPS series has started again.

CHART 10: NOMINAL TREASURY RATES*

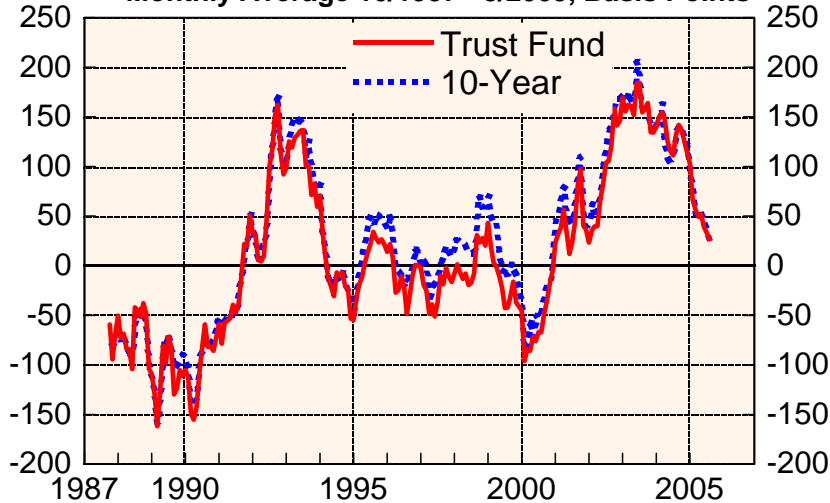
Monthly Average 10/1987 - 8/2005, Percent



* Long-term forward rate computed from Bloomberg Generic Coupon Strips of 10 and 30 years maturity. Returns computed from Trust Fund and Treasury constant maturity yields.

CHART 11: NOMINAL TREASURY SPREADS: LONG-TERM FORWARD RATE TO NOMINAL RETURNS

Monthly Average 10/1987 - 8/2005, Basis Points



Averages, Whole Period:
Trust Fund: 11
10-Year: 25

Averages, Last 10 Years:
Trust Fund: 36
10-Year: 54

Changes in inflation can affect this premium in the nominal market. By focusing on the last ten years when inflation was relatively stable, these two charts point to a net term premium of at least 35 basis points. Because Chart 9 might imply a higher premium, the TIPS and nominal markets together suggest a lower limit for the net term premium of 35 basis points.

Given the term premium, the expected TIPS long-run real return can be estimated by subtracting the net term premium from the TIPS long-run forward rate. Therefore, the average long-run forward rate of 2.58 percent since mid 2002 together with a net term premium of 35 basis points or more implies a long-run expected return of about 2-1/4 percent or less. Recent long-run forward rates at around 2 percent may indicate an even lower expectation.

Of course, if current TIPS rates are abnormally low, long-run forward rates may also be biased down if markets simply extrapolate expectations from the present. Nevertheless, the apparent low expectations for future TIPS returns have persisted for several years or more, so it must be considered a real possibility that markets are looking to a future of low real interest rates.

In sum, TIPS markets have solidly priced in a TIPS long-term real return which is at most 2-1/4 percent. Current returns are around 2 percent, and so are expected future returns.

The preceding calculations provide the expected return on a TIPS trust fund. The expected long-term real return for the actual Trust Funds made up of nominal Treasuries can be derived by adjusting the expected TIPS long-term real return.

The adjustment includes the inflation risk premium net of offsetting effects. Early analytical work suggests that the most likely upper limit of the inflation risk premium is 50 basis points.⁹ After allowing for offsetting effects such as the tax effects of TIPS and the lesser liquidity of TIPS, the net adjustment may be lower.

However, even with the upper adjustment limit of 50 basis points, the TIPS long-term real return of 2-1/4 percent or less would imply that the expected long-term real return on the nominal Trust Funds would fall below 2-3/4 percent.

Therefore, based on the hypothetical TIPS trust fund derived from the TIPS yield curves, the expected long-term real return adjusted to be comparable to the real return on the Social Security Trust Funds is around 2-3/4 percent.

⁹ For more on estimating the inflation risk premium, see Hammond (2002).

Conclusions

This paper updates and extends previous work which considers the real interest rate on the Social Security Trust Fund. The paper adds 2005 data to the previous extensive historical series, and the resulting average long-term government real interest rate back through 1870 is just under 3 percent. Over the last 40 years or so, the Trust Fund rate has been about 24 basis points below the long-term government rate. The paper then extends previous work by using yield curves for Treasury inflation-indexed securities (TIPS) to develop forward-looking market projections for the real return on a hypothetical trust fund made up of TIPS. The comparable average real return on the hypothetical trust fund is roughly estimated to be around 2-3/4 percent.

Appendix

The Yield Curve for TIPS

The TIPS yield curves presented in this paper use the yield curve methodology developed in this Office.¹⁰

The price quotes used to compute these curves were provided by Treasury's Office of Debt Management. They consist of daily quotes for business days from April 15, 1999 through December 30, 2005, where the choice of early 1999 as the start date minimizes some of the abnormalities in the prices when these securities were new in the market. Price quotes for days before each security's issue date were removed.

As of December 30, 2005, there had been a total of 18 inflation-indexed securities issued with 17 still outstanding and an early 5-year issue having matured in 2002 (quotes for this security during the last year of its existence were eliminated). The resulting sample of quotes contained at least 6 securities outstanding for each quote day.

The methodology for computing the yield curves starts by expressing the price of each security as the discounted sum of the security's real cash flows, where the discount factors are given by a discount function. The spot and par yield curves are calculated from the discount function.

The discount function is written in terms of the forward rate, which, in turn, is modeled as a cubic spline. The knots of the spline are placed at maturities 0, 7, 10, and 31-1/2 years. The quote sample for each day includes at least one security whose maturity is within each of these knot ranges.

In addition, the spline is constrained in several ways including endpoint constraints for smoothness. And in order to generate a seamless projection, the forward rate at and beyond 31-1/2 years maturity is made to equal its average from 10 to 31-1/2 years.

The parameters of the spline are estimated for each daily quote sample by nonlinear least squares with no weighting. The splines are written in terms of B-spline bases for estimation. The resulting spline parameters define the discount function from which the various yield curves are derived. And the long-run forward rate is given as the resulting average of the forward rate from 10 to 31-1/2 years maturity.

¹⁰ See the discussion on p. 10 of the previous paper Girola (2005). For more information about this methodology as applied to the corporate bond market, see U.S. Department of the Treasury (2005a, 2005b, and 2006).

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