ESTIMATING CHANGES IN MARKET EXPECTATIONS OF INFLATION IN RESPONSE TO FEDERAL RESERVE RATE CUTS IN JANUARY 2008

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ABSTRACT

The calculation of forward rates implied in Treasury spot rates is well known. A simple extension that uses yields on TIPS and similar-maturity conventional Treasury securities to estimate changes in the market's expectation of inflation is less well known. One interesting opportunity to apply this method arose in January 2008 around the time of two substantial federal funds target rate cuts by the Federal Reserve. Near-term and longer-term inflation expectations appear to have responded differently to the first and second interest rate cuts, which were only ten days apart. After reporting our results, we discuss potential limitations of this method.

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1. INTRODUCTION

It is well known that the Treasury yield curve may be used to solve for forward rates that are implied in the spot rates of conventional Treasury securities with varying maturities. If, consistent with the pure expectations theory, the shape of the term structure is driven primarily by the market's expectations of future interest rates, it is possible to use these forward rates as estimates of the market expectations of future spot interest rates. A less well known extension of this method, which has been applied by some economists and finance professionals,[1] is the analogous estimation of market expectations of spot and forward inflation rates using the yields of conventional Treasury securities and similar-maturity Treasury Inflation-Protected Securities (TIPS).

Estimating market forecasts of future inflation rates may be considered important, because the inflation compensation investors require is an important determinant of most interest rates. Furthermore, in times when inflation rates are likely to change, it is useful to derive market estimates of expected changes in future inflation rates, not only for purposes of verifying forecasts of future interest rates, but also for capital budgeting purposes and for the pricing of CPI futures contracts (CME, 2004). And, finally, awareness of this estimation technique increases investors' understanding of the characteristics and usefulness of TIPS, which have increasingly been included in the portfolios of many institutional and individual investors (Healey and Varrelman, 2005; and Thau, 2007).

One interesting opportunity to examine changes in the market's inflation expectation arose in January 2008 around the time of two substantial federal funds target rate cuts by the Federal Reserve. We find that near-term and longer-term inflation expectations responded differently to the first and second interest rate cuts, which were only ten days apart.

The discussion of this case is organized as follows. Section two summarizes the relevant characteristics of TIPS. Section three demonstrates how the spot rates of TIPS together with the spot rates of similar-maturity conventional Treasury securities may be used to obtain market estimates of changes in spot short-term and longer-term inflation expectations. We also show how forward rates on these instruments may be used to estimate changes in the market's future inflation expectations. Section four demonstrates the calculations using readily available data for a recent time period during which the Federal Reserve announced two substantial rate cuts only ten days apart. Section five reports and interprets the results. Section six discusses caveats that should be considered when using these estimates as forecasts of future inflation rate changes. Section seven concludes.

II. CHARACTERISTICS OF TIPS

TIPS were introduced by the U.S. Treasury in 1997. They are issued with terms to maturity of five, ten, and twenty years. Similar to conventional Treasury securities, TIPS are free of default risk. But unlike conventional Treasury securities, TIPS protect investors from the purchasing power losses associated with a rising aggregate price level by adjusting cash flows for changes in the Consumer Price Index (CPI-U). Adjustments are made to a security's par value on coupon payment dates and on the maturity date. Coupon payments are adjusted because they are calculated by applying the coupon rates, which are set and fixed at auction, to the inflation-adjusted principal.[2] Thus, the yield-to-maturity on TIPS approximates the average real risk free interest rate over the security's life.

Similar to the tax treatment of conventional Treasury securities, the coupon payments of TIPS are taxable when received. The inflation adjustment to the TIPS par value is taxable in the year in which the adjustment occurs, but the inflation adjustment is not received until maturity. For this reason, it is typically recommended that TIPS be held in tax-deferred retirement accounts. In spite of this drawback, the size of the TIPS market has grown in recent years. As of December 2007, the amount of TIPS outstanding exceeded $470 billion. TIPS accounted for slightly more than 10% of the total marketable federal debt.

III. CHANGES IN SPOT AND FORWARD BREAKEVEN INFLATION

The finance profession has used the term "Break Even Inflation" (henceforth BEI) to denote the inflation protection received by investors in conventional Treasury securities. BEI can be calculated using the Fisher equation

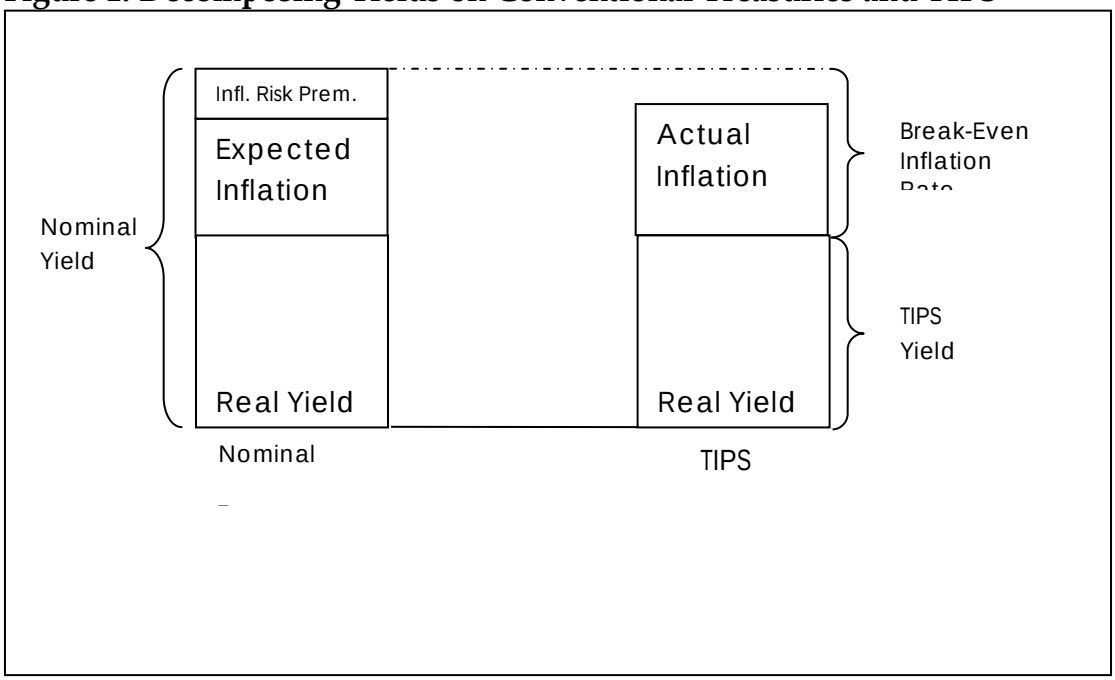
$$BEI_n = \frac{(1+nomtal_n)}{(1+real_n)} - 1 \qquad (1)$$

where $nominal_n$ is the spot nominal rate for a conventional Treasury security with n years to maturity, $real_n$ is the spot real rate for TIPS with n years to maturity, and BEI_n is the spot BEI for an n-year period.[3] When actual inflation equals the BEI, investors "break even" in the sense that they receive equivalent returns on conventional Treasuries and comparable TIPS. When actual inflation proves higher than the BEI, TIPS perform better than conventional Treasuries and when actual inflation is lower than the BEI, conventional Treasuries are preferred.

It is well known (see, for example, Kwan, 2005) that the BEI may overstate the market's spot inflation expectation by the inflation risk premium that is embedded in the BEI (see Figure 1). While it is difficult to obtain accurate readings of the magnitude of the inflation risk premium relative to the market's

spot inflation expectation, recent research results suggest that changes in the BEI are pretty good estimates of changes in the market's inflation expectation and attitude toward inflation risk (D'Amico et al., 2006; and Guerkaynak et al., 2008).[4]

Figure 1: Decomposing Yields on Conventional Treasuries and TIPS[5]



In the following section, we calculate changes in the BEI for time horizons of five, seven, ten and twenty years. We also calculate changes in forward break even inflation in order to estimate changes in the market's expectation of future inflation rates. To do this, we use the BEI rates for different maturities to determine Forward Break Even Inflation (FBEI) rates. The process is similar to determining forward interest rates using the spot rates of different maturities. The pure expectation hypothesis states that any long term interest rate is a geometric mean of short term rates expected to prevail over that period. Assuming the pure expectation theory holds for nominal and real rates, we can decompose any multi-year BEI into its one-year BEI and FBEI components as follows:

$$(1 + BEI_{0,n}) = [(1 + BEI_{0,1})(1 + FBEI_{1,1}) \ldots (1 + FBEI_{n-1,1})]^{\frac{1}{n}} \qquad (2)$$

where $BEI_{0,n}$ is the average spot Break Even Inflation rate for n periods. $FBEI_{i,1}$ is the Forward Break Even Inflation rate starting at time period i and lasting for one period. Since data are available for 5-, 7-, 10-, and 20-year maturities only, we determine FBEI rates for multiple time periods. For example, the average FBEI rate for a two year time horizon starting at the end of the fifth year can be computed as follows:

$$(1 + FBEI_{5,2}) = \left[\frac{(1 + BEI_{0,7})^{7}}{(1 + BEI_{0,5})^{5}}\right]^{\frac{1}{2}}$$

Similar to changes in the BEI, which we interpret as changes in the market's expectation of spot inflation rates, we calculate changes in FBEI to estimate changes in the market's expectation of future inflation rates.
In the following section, we use daily rate observations for January 14, 2008 through February 6, 2008 to analyze whether aggressive monetary easing by the Federal Reserve during that time period had any immediate impact on market expectations of spot and future inflation rates.

IV. DATA AND CALCULATIONS

The Federal Reserve decreased the federal funds target rate by 75 basis points on January 22, 2008 and by an additional 50 basis points on January 30, 2008.

Table 1: Changes in the Federal Funds Target Rate[6]

Date	*Old Level*	*Change*	*New Level*
Jan 22,2008	4.25	-0.75	3.50
Jan 30, 2008	3.50	-0.50	3.00

We use data from five days before the first announcement to five days after the second announcement to estimate changes in BEI and FBEI rates. Interest rate data are obtained from the Federal Reserve Statistical Release[7]. For each day, we extract data for Treasury Constant Maturity Nominal rates (nominal) and Treasury Constant Maturity Inflation Indexed rates (real). Data are available for four maturities: five, seven, ten and twenty years. Though nominal rates are available for other maturities, the inflation indexed (real) rates

are only available for these four maturities. Using equation 1, we calculate 5-year, 7-year, 10-year and 20-year BEI rates.

Table 2: Spot BEI rates on January 22, 2008

Maturity	*Nominal*	*Real*	*Break Even Inflation*
5	2.64	0.67	$BEI_5 = \frac{(1+.0264)}{(1+.0067)} - 1 = 0.0196$ or 1.96%
7	3.01	1.05	$BEI_7 = \frac{(1+.0301)}{(1+.0105)} - 1 = 0.0194$ or 1.94%
10	3.52	1.28	$BEI_{10} = \frac{(1+.0352)}{(1+.0128)} - 1 = 0.0221$ or 2.21%
20	4.23	1.72	$BEI_{20} = \frac{(1+.0423)}{(1+.0172)} - 1 = 0.0247$ or 2.47%

Due to the inflation risk premium, the BEI is likely to be a biased measure of the market's expectation of spot inflation. However, if the inflation risk premium can be assumed to remain constant for short periods of time, day-to-day changes in the BEI should reflect day-to-day changes in the market's expectations of spot inflation rates. We calculate day-to-day changes for the 5-year, 7-year, 10-year and 20-year BEI.

We then use our results for the BEI rates, and equation 2, to calculate the following FBEI rates: the 2-year FBEI for the end of year 5 ($FBEI_{5,2}$), the 5-year FBEI for the end of year 5 ($FBEI_{5,5}$), and the 15-year FBEI for the end of year 5 ($FBEI_{5,15}$). In order to reduce the effect of the inflation risk premium on our FBEI results, we estimate changes in the market's future inflation expectations by calculating the day-to-day changes in FBEI for January 14, 2008 to February 6, 2008. We then analyze BEI and FBEI changes for the 7-year, 10-year, and 20-year time horizons to determine whether there were differences in the way market inflation expectations in the spot and forward markets reacted to the first and second rate cuts. These results are reported in the following section.

V. RESULTS AND INTERPRETATION

Inflation expectations change as new information comes to the market. Prices and yields of regular Treasury bonds and TIPS incorporate this information. Generally, new information pertaining to inflation is incrementally

small, and thus any direct changes to yields are difficult to observe. One episode of sudden and substantial new information arrival occurred when the federal funds target rate was cut by 75 and, ten days later, by another 50 basis points in January 2008. These rate cuts provide a unique opportunity to study the effect of changes in the federal funds target rate on inflation expectations.

A rate increase tends to restrict the availability of money, and thus should reduce inflation expectations. Conversely, a rate cut would be expected to increase inflation expectations because the Federal Reserve provides added liquidity. However, it is conceivable that an unexpected emergency rate cut triggers a reduction in inflation expectations if the market interprets the rate cut as a response to a sudden and severe deterioration in the economy, which would reduce pressure on the aggregate price level.

In the case studied here, a rate cut was expected by the market in the beginning of 2008. However, the date and the magnitude of the first rate cut were unexpected and occurred 10 days before a regularly scheduled Federal Open Market Committee meeting. It represented the Federal Reserve's emergency response to a perceived market crisis. The second rate cut occurred at a regularly scheduled meeting of the FOMC. To the extent the first rate cut signaled the Fed's increased concern with a difficult financial and economic situation, the market's response to it may have been different from the market's response to the second rate cut that followed only 10 days later.

Figure 2 shows our results for day-to-day changes in BEI for five and seven years and in the 2-year FBEI for the end of year 5. It is interesting to note that the day-to-day changes in the 5-year BEI are negative at the time of the first rate cut. The market apparently interpreted the emergency rate cut on January 22nd as confirmation of negative news about the economy and reduced near-term inflation expectations. In contrast, the 5-year BEI increased around the time of the second rate cut. Apparently, the market viewed the second rate cut as contributing to near-term inflationary pressures. The changes in the 2-year FBEI for the end of year 5 indicate slightly greater concern with inflation for the years after the 5-year time horizon. Overall, the changes in the 2-year FBEI follow the same pattern as the changes in the 5-year BEI, although they are less negative at the time of the first rate cut and more volatile at the time of the second rate cut. As a result, there is not much difference between the changes in the 5-year average BEI and the changes in the 7-year average BEI. This is not surprising because there is not much difference between a 5-year and a 7-year time horizon.

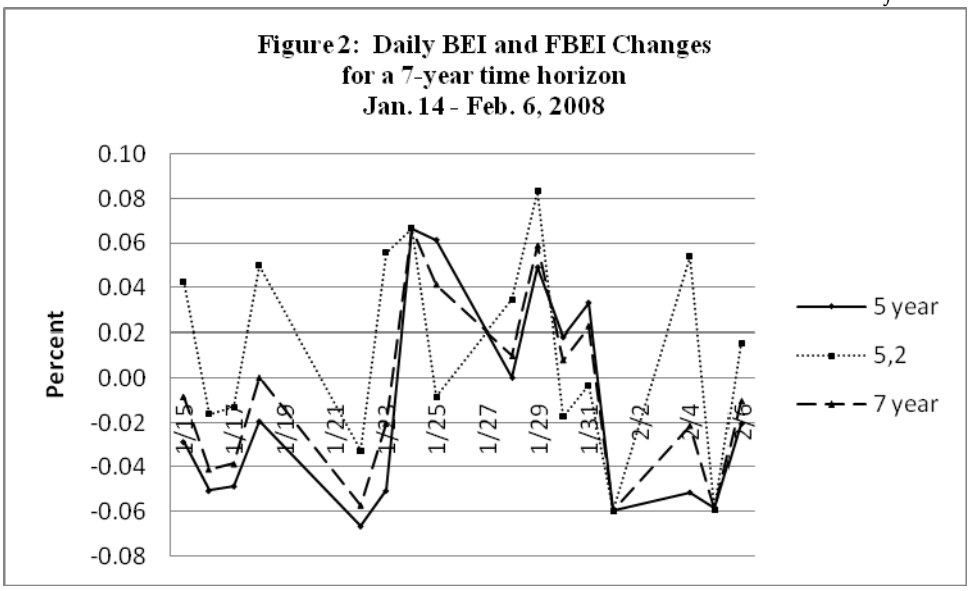
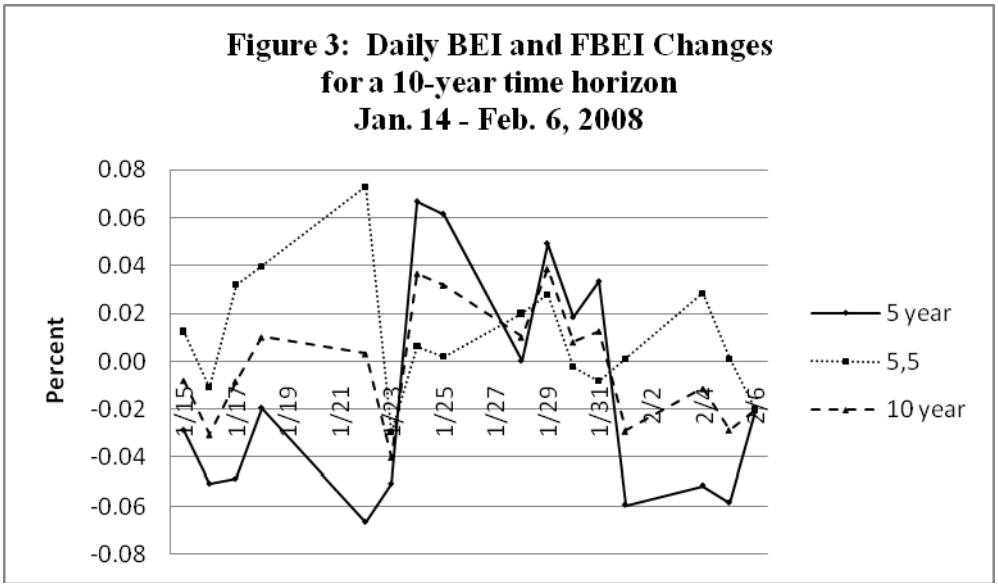


Figure 3 shows our results for day-to-day changes in BEI for five and ten years and in the 5-year FBEI for the end of year 5. This graph shows greater discrepancy between changes in the 5-year BEI and changes in the 5-year FBEI for the end of year 5. Interestingly, the market's expectations of inflation from years 5-10 increased, while expectations for inflation during the first five years decreased on and before January 22nd. After that date, the relationship reversed. Increases in the spot inflation expectation tended to exceed increases in the forward inflation expectation until January 30th. After the second rate cut, there was another reversal with FBEI changes being more positive than BEI changes. This same pattern is also observable in Figure 4 for the 20-year time horizon.



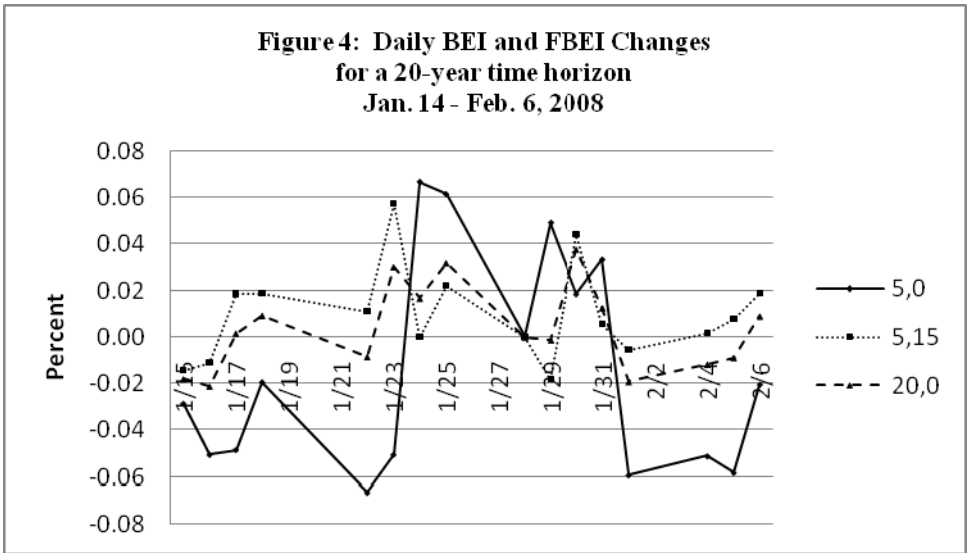


Table 3: Comparison of BEI and FBEI rates (in percent): January 14th, 2008 versus February 6th, 2008

Date	*5-year BEI*	*7-year BEI*	*10-year BEI*	*20-year BEI*	*2-year FBEI after year 5*	*5-year FBEI after year 5*	*15-year FBEI after year 5*
Jan14	2.17	2.08	2.25	2.50	1.87	2.32	2.62
Feb 6	1.95	1.98	2.22	2.57	2.06	2.49	2.77
Percent Change	-10	-5	-1	+2	+10	+7	+6

In summary, it appears that the first rate cut initially reduced near-term inflation expectations relative to longer-term inflation expectations, but then elevated near-term inflation worries relative to longer-term inflation concerns until shortly after the second rate cut when the relationship reversed again.

It is also interesting to look at net changes in BEI rates and FBEI rates for the period examined. Comparing our results for February 6th to those for January 14th, we find that the BEI rates fell, except for the 20-year BEI, which rose (see Table 3). The net change for all FBEI rates was positive as well indicating that the market expected inflation to increase in the later years rather than the earlier years as a result of the dual rate cuts.

VI. CAVEATS

This case illustrates a simple procedure for calculating changes in market expectations of inflation. It is important, however, to be aware of possible limitations of this methodology. We chose to focus on measuring *changes* in inflation expectations, because this helps reduce the upward bias in estimates of BEI that results from the inflation risk premium embedded in nominal Treasury rates. The upward bias likely increase with the time to maturity, as greater uncertainty is associated with the more distant future. But even if this bias is present, changes in BEI rates (and in FBEI rates) should be pretty good measures of changes in the market's inflation expectations and investor attitudes toward inflation risk.

Another source of possible bias is the liquidity premium that investors likely require as part of the yield on TIPS. This liquidity premium, which likely was nontrivial particularly during the early years of the TIPS market's existence, would result in underestimation of the BEI and FBEI. Empirical evidence by D'Amico et al. (2006) documents the existence of a liquidity premium, particularly in the years after TIPS were first issued, but also confirms that changes in BEI are fairly good estimates of changes in the market's inflation expectation and investor attitudes towards inflation risk.

The inflation adjustment for TIPS is based on reported estimates of changes in the Consumer Price Index. To the extent the CPI misestimates the true inflation, the BEI and FBEI rates may misestimate the market's true inflation expectations. The CPI has been shown to be an inaccurate measure of true inflation. Furthermore, it is lagged. Therefore, the BEI and FBEI estimates reflect the same lag.

It is also worth pointing out that we calculate inflation expectations in increments of complete years. However, if inflation expectations are calculated in cases where the time period is not in complete years, an adjustment for the seasonality of inflation must be made.

And, finally, inflation expectations may fluctuate for many reasons. It is impossible to attribute any given change to any particular event. Price movements may be due to differences in duration and convexity between conventional Treasuries and corresponding TIPS, or simply noise in market data.

VII. CONCLUSION

We show how the yields on conventional Treasury securities and TIPS may be used to extract changes in BEI and FBEI rates as estimates of changes in spot and forward inflation expectations. As an example, we focus on a three-week period at the beginning of 2008 when the Federal Reserve was particularly aggressive in addressing threats to financial and economic stability. We calculate day-to-day changes in BEI and FBEI for a three-week period to see whether there were any differences in the way the market's spot and forward inflation expectations responded to the Federal Reserve's first and second rate cuts.

It is important to point out that some of the BEI and FBEI rate fluctuations may be attributed to noise or other events that occurred during the same time period as the rate cuts. Nonetheless, it does appear that the market's spot inflation expectations for the near term (five years) fell when the first rate cut was announced. Before and at the time of the second rate cut, those inflation expectations rose relative to the longer-term inflation expectations. And after the second rate cut, the near-term inflation expectations fell again.

While it is interesting to examine daily changes in inflation expectations at the time of particular monetary events, this methodology may also be used to examine changes in market expectations of inflation and attitudes towards inflation risk over much longer periods of time.

NOTES

[1] Finance professionals are aware of the ability to extract inflation expectations from the yields of conventional Treasury securities and TIPS. See, for example, the following discussions in the financial press: "How bad is inflation, really?" Mark Hulbert, CBS MarketWatch, January 14, 2008; and "A Fear that the Cure Could be Poison," Edmund L. Andrews, The New York Times, January 24, 2008.

[2] Cash flows are inflation-protected with a delay of up to three months due to CPI reporting delays and design of the calculation method used.

[3] Differences in prices and yields between conventional Treasuries and TIPS may occur due to differences in duration and convexity. We assume that similar maturity securities are also comparable with respect to duration and convexity.

[4] Guerkaynak et al. (2008) provide evidence that suggests fluctuations in the inflation risk premium may be particularly large for the longer-term (10-year) BEI.

[5] This picture of the relationship between nominal and real yields was originally provided by Greg Wilensky of Alliance Capital. It was reproduced in "Break-Even Inflation – A Primer", Chicago Mercantile Exchange, January 29, 2004.

[6]Data obtained from
http://www.newyorkfed.org/markets/statistics/dlyrates/fedrate.html

[7] Please see http://www.federalreserve.gov/releases/h15/data.htm

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