# TIPS as an Asset Class

Peng Chen
Ibbotson Associates
225 N. Michigan Ave., Suite 700
Chicago, IL 60601
(312) 616 -1620

Matt Terrien[1]
Ibbotson Associates
225 N. Michigan Ave., Suite 700
Chicago, IL 60601
(312) 616 -1620

November 1999

[1] Peng Chen is a Senior Research Consultant and Matt Terrien is a Consultant at Ibbotson Associates in Chicago, Illinois.

## TIPS as an Asset Class

*Abstract*

When designing investment portfolios within a long-term strategic asset allocation context, the authors maintain that TIPS (Treasury Inflation-Protection Securities) should be evaluated as a separate, distinct asset class. These securities possess unique characteristics that are not directly available through other investment vehicles. Their most significant benefit lies in the fact that they provide a direct hedge against one specific measure of inflation (i.e. the non-seasonally adjusted Consumer Price Index for all urban consumers; CPI-U); which allows investors to maintain real purchasing power and hedge against future nominal increases in the overall domestic price level. In addition to their obvious appeal to investors guarding against increases in inflation, TIPS may also appeal to a broader audience by virtue of their relatively low correlation with other traditional asset classes. The authors demonstrate that TIPS offer potentially significant diversification benefits, establishing them as a viable asset class to be considered when constructing a long-term asset allocation policy.

## Introduction

Although inflation-indexed bonds have existed in other nations (e.g. U.K., Israel, Australia, etc.) for a number of years, U.S. TIPS were first auctioned in January 1997. Unlike conventional Treasury bonds that have fixed nominal coupon rates, the coupon payments of TIPS are fixed in ***real*** terms at the time of issuance. That is, over the life of the bond, nominal interest payments are adjusted based on the actual inflation rate (as measured by changes in the CPI-U). TIPS' par values are also adjusted in a similar manner, such that the principal is returned to the investor upon maturity, fully adjusted for inflation. An example may clarify how this process works. Assume a ten-year inflation-indexed bond is issued with a par value of $10,000 and guarantees a real yield of 3% per year. Suppose that the inflation rate is 5% in the first year. The face value of the bond will rise to $10,500 and the coupon payment would be $315 (i.e. 3% of $10,500)[2]. If deflation occurs, the principal and the coupon payment will be adjusted down based on the falling CPI-U. However, if deflation reduces the principal below par, the investor will still receive the par value at maturity. As Wrase [1997] points out, though, "the Treasury does not expect to have to implement this 'minimum guarantee' because it does not expect a prolonged decline in consumer prices to occur." TIPS ensure that neither the U.S. Treasury nor the investor faces the risk that an unanticipated increase or decrease in inflation will erode or boost the purchasing power of the bond payments. Thus, TIPS are structured in a manner that allows them to maintain their real value, thereby offering a long-term hedge against inflation[3].

[2] This hypothetical example assumes a single annual coupon payment. In practice, the interest payments on TIPS are made semi-annually.

[3] Although TIPS are significantly more apt to preserve real purchasing power than traditional nominal bonds are, they do not provide a completely perfect hedge against inflation. Semi-annual coupon payments are subject to reinvestment risk. Also, an investor's specific liabilities may increase at a faster rate than the CPI-U; therefore, making TIPS a less than effective funding vehicle for such expenses. Taxable investors are partially exposed to inflation risk due to the tax code's current inability to distinguish between nominal and real income. An increase in a TIPS' principal value is taxable as normal interest income, even though the adjustment simply keeps the principal value fixed in real terms. This problem of taxes exposing a TIPS investor to inflation risk is dealt with more thoroughly by Shen [1998]. Finally, as Wrase [1997] illustrates, "inflation-indexed bonds . . . are subject to an 'indexation lag' - bond payments are linked to a [3-month] lagged value of a price index. Because of the indexation lag, an indexed bond also lacks inflation protection for a short period right before it matures."

## Performance

As of October 31, 1999 TIPS accounted for less than 2% of total outstanding U.S. government debt. The total market value of TIPS is $100.1 billion, whereas total outstanding government debt is $5.59 trillion. There are currently six available TIPS issues. As outlined in Table 1, below, the current yield differential between TIPS and similar maturity nominal bonds tends to hover near 200 basis points for maturities under 10 years, whereas a slightly higher differential exists for the longer maturities.

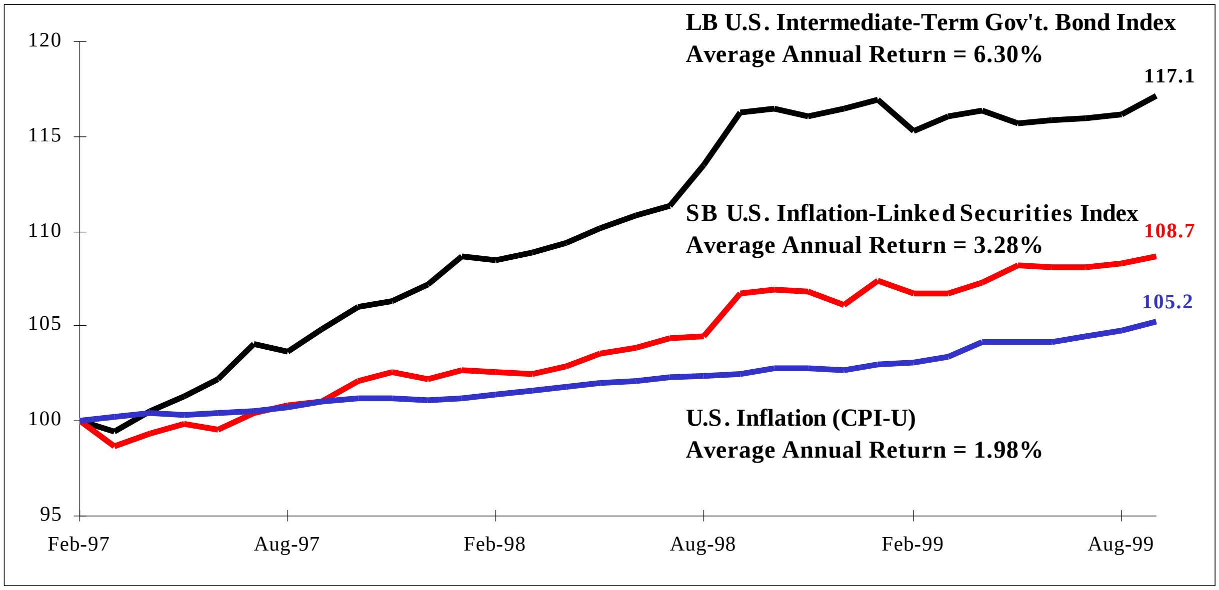
Table 1 - Yield Comparison of Existing TIPS Issues and Similar Maturity "Nominal" Bonds

| TIPS | | | "Nominal Bonds" | | | |
|---|---|---|---|---|---|---|
| Coupon | Maturity | Yield[4] | Coupon | Maturity | Yield[3] | Yield Differential |
| 3 5/8 % | July 15, 2002 | 3.83% | 6 % | July 31, 2002 | 5.85% | 2.02% |
| 3 3/8 % | January 15, 2007 | 4.11% | 6 ¼ % | February 15, 2007 | 6.17% | 2.06% |
| 3 5/8 % | January 15, 2008 | 4.11% | 5 ½ % | February 15, 2008 | 6.15% | 2.04% |
| 3 7/8 % | January 15, 2009 | 4.10% | 5 ½ % | May 15, 2009 | 6.07% | 1.97% |
| 3 5/8 % | April 15, 2028 | 4.11% | 5 ½ % | August 15, 2028 | 6.34% | 2.23% |
| 3 7/8 % | April 15, 2029 | 4.11% | 5 ¼ % | February 15, 2029 | 6.26% | 2.15% |

For the majority of their existence U.S. TIPS have outperformed the CPI-U measurement of inflation. They have underperformed the broader Government Treasury market by a significant margin, however. Figure 1, below, illustrates these trends.

[4] Yield figures represent yield to maturity on accrued principal as reported in the Wall Street Journal, November 1,1999.

Figure 1- Historical Performance of TIPS (March 1997- September 1999)[5]




As Sargent and Taylor [1997] point out:

> "The performance of TIPS compared to nominal Treasury securities depends on the actual rate of inflation relative to expectations. If actual inflation ends up being less than what the market anticipates, TIPS will underperform conventional Treasury securities. Conversely, if actual inflation exceeds expected inflation, TIPS will pay a higher rate of return than conventional Treasuries. The main difference hinges on the accuracy of the market's predictions about future inflation. If inflation forecasts prove to be correct, then in theory, TIPS' performance will lag that of traditional Treasuries because the return on the latter includes a premium for inflation risk. However, because TIPS have liquidity problems, the difference in returns will depend on the relative sizes of the inflation risk and liquidity premiums."

Rather than attempting to explain the recent, short-term performance of TIPS or prognosticating their near-term outlook, we turn our attention to forecasting mean-variance optimization inputs for TIPS, to be used in the context of a long-term strategic asset allocation policy.

[5] Average annual return statistics based on monthly, annualized data.

## Return, Risk and Correlation of TIPS

From a conceptual standpoint, inflation-indexed bonds are expected to provide slightly lower return and risk than traditional, nominal government bonds with similar maturities. The explanation for this lies in the fact that inflation-indexed bonds hedge away the inflation risk associated with regular bonds. An increase in inflation prompts investors to require higher yields from nominal bonds in order to compensate for the loss of purchasing power; this results in a drop in the prices of these instruments. TIPS, however, have both their principal amount and coupon payments adjusted to reflect changes in inflation. The inflation protection received by TIPS investors is valuable, and this value is paid for in the form of lower yields as compared to regular bonds. Due to the fact that inflation impacts traditional bonds quite differently than TIPS, the correlation coefficient between the two is expected to be low. When inflation increases, the prices of both equities and nominal bonds decrease (as investors require higher discount rates for future dividends and coupon payments). Therefore, the correlation between equity and TIPS is also expected to be lower than the correlation between equities and nominal bonds.

To incorporate inflation-indexed bonds in a long-term asset allocation framework using mean-variance analysis, it is necessary to analyze their expected return, standard deviation and correlation coefficients with other asset classes. An examination of historical data would be helpful when estimating these mean-variance inputs. Inflation-indexed bonds, however, were introduced less than three years ago here in the United States. The existing data sample is insufficient for estimating long-term mean-variance inputs. Instead, synthetic inflation-indexed bond series were created, based on historical inflation and Treasury bond yield data[6]. For the purposes of this study, a synthetic 10-year inflation-indexed bond was utilized.

[6] A synthetic return series for inflation-indexed bonds was created covering the 1970 – 1998 time period. Appendix A provides a detailed description of the methodology employed to create this series.

Table 2 provides the historical average return, standard deviation and correlation coefficients of synthetic 10-year inflation-indexed bonds, U.S. stocks, 10-year U.S. Treasury bonds, and 30-day U.S. Treasury bills. The synthetic inflation-indexed bonds have exhibited lower return and lower risk than 10-year Treasury bonds. The correlation coefficients between inflation-indexed bonds and the other asset classes were quite low. As expected, the correlation coefficient between synthetic inflation-indexed bonds and equities was lower than that between the regular 10-year Treasury bonds and equities.

**Table 2 -- Nominal Return, Risk, and Correlations (1970-1998)**

| | | | Correlation Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| | Return % | Standard Deviation % | TIPS | S&P 500 | 10-Yr. T-Bond | 30-Day T-Bill | Inflation |
| TIPS (Synthetic 10-Year) | 8.84 | 9.16 | 1.00 | | | | |
| S&P 500 | 14.68 | 16.21 | - 0.04 | 1.00 | | | |
| 10-Year Treasury Bond | 9.98 | 9.98 | 0.07 | 0.41 | 1.00 | | |
| 30-Day Treasury Bill | 6.8 | 2.66 | 0.08 | - 0.10 | 0.04 | 1.00 | |
| Inflation | 5.26 | 3.29 | 0.28 | - 0.39 | - 0.45 | 0.58 | 1.00 |

Table 3 provides the same statistics as table 2, however the information in table 3 reflects inflation-adjusted (i.e. real) data. The synthetic inflation-indexed bonds have exhibited lower real return and lower real risk than 10-year Treasury bonds. The inflation-adjusted correlation coefficient between synthetic inflation-indexed bonds and equities is slightly higher than it is in nominal terms; however, it is still considerably lower than the inflation-adjusted correlation coefficient between the regular 10-year Treasury bonds and equities. The low correlation coefficients between inflation-indexed bonds and the other asset classes (especially equities), suggest that potential diversification benefits exist from the addition of TIPS to a portfolio consisting of traditional assets.

**Table 3 -- Real Return, Risk, and Correlations (1970-1998)**

| | Return % | Standard Deviation % | Correlation Coefficients TIPS | S&P 500 | 10-Yr. T-Bond | 30-Day T-Bill |
|---|---|---|---|---|---|---|
| TIPS (Synthetic 10-Year) | 3.43 | 8.44 | 1.00 | | | |
| S&P 500 | 9.24 | 16.73 | 0.12 | 1.00 | | |
| 10-Year Treasury Bond | 4.72 | 11.30 | 0.23 | 0.55 | 1.00 | |
| 30-Day Treasury Bill | 1.52 | 2.62 | - 0.02 | 0.46 | 0.67 | 1.00 |

## Role of Inflation Indexed Bonds in Strategic Asset Allocation

To evaluate the desirability of including inflation-indexed bonds in the asset allocation decision, mean-variance optimization was performed in both a nominal and real (inflation-adjusted) setting. The four asset classes mentioned above were used in the analysis.

### Historical Mean-Variance Analysis in Nominal Terms (1970-1998)

Figure 2 shows two mean-variance efficient frontiers; one with the synthetic 10-year inflation-indexed bond asset class, and one without.[7] The inputs used in this mean-variance analysis are presented above in table 2. The lower efficient frontier excludes inflation-indexed bonds from consideration; the upper frontier includes them. This figure shows that adding TIPS improves the risk-return tradeoff of the mean-variance efficient frontier. Figures 3 and 4 show the allocations of the two efficient frontiers, respectively. The allocation to TIPS ranges from 0% for the highest-risk portfolio to over 35% for a moderate-risk portfolio. The efficient allocation to TIPS is greater than zero for all portfolios on the efficient frontier except for the highest-risk portfolio, which consists of 100% U.S. equity. The efficient allocations to equities are roughly the same with and without TIPS. The allocation to TIPS mainly comes at the expense of bonds and cash. The allocations to regular bonds are still positive, albeit smaller, when TIPS are included; thus, the inclusion of TIPS does not completely eliminate regular bonds.

[7] Efficient frontiers and portfolio allocations shown in this study are intended for illustrative purposes only. They do not necessarily represent Ibbotson Associates 'advice.

### Historical Mean-Variance Analysis in Real Terms (1970-1998)

Figure 5 shows the results of the mean-variance analysis in real return space. In this scenario, return and risk are inflation-adjusted, which is appropriate for investors who are concerned about the purchasing power of their portfolios. The real return, risk, and correlation coefficients of TIPS and the other three asset classes are presented above in table 3. The upper efficient frontier is the result of including TIPS in the efficient portfolios of traditional stocks, bonds and cash. Including TIPS improves the real risk-return efficiency of traditional stock, bond and cash portfolios. Figures 6 and 7 provide the detailed allocations of the portfolios from the two frontiers shown in Figure 5. TIPS play an important role in the efficient portfolios. The allocations to TIPS range from about 10% in the minimum variance portfolio to about 50% for moderate-risk portfolios. The allocations to equities are not significantly affected by the inclusion of TIPS in real return space. Allocations to bonds and cash are considerably lower after TIPS are included. Nominal bonds are almost completely replaced by TIPS.

Comparing the efficient allocations in real return space with those in nominal return space yields some interesting results:

1) The allocation to TIPS is greater in real return space than in nominal return space. This indicates that the benefit of including TIPS in a portfolio is greater in real return space (i.e. for investors whose objective is to maximize inflation-adjusted returns and minimize risk).
2) The allocation to regular bonds is much smaller in real return space than in nominal return space regardless of whether TIPS are included or not.
3) Allocations to equities remain about the same in both real and nominal return space.

Including TIPS improves the risk-return tradeoff of the mean-variance efficient frontier in both nominal and real terms. Investing part of a portfolio in TIPS helps investors achieve a higher expected rate of return and lower expected risk. The diversification benefits of TIPS are obvious, especially in the case of real risk and return tradeoffs.

## Conclusions

Overall, this study shows that TIPS provide more diversification benefits than regular fixed income securities. This advantage is more significant in the analysis of real return space. TIPS also provide a unique opportunity for investors to hedge inflation risk. Since TIPS are relatively new investment vehicles, the market for these securities is not as efficient as those for other asset classes. TIPS ' market size is small and their liquidity is low compared to other fixed income securities. This has prevented institutional investors from investing a significant portion of their monies in TIPS. As a result, the real yield of TIPS is currently over 4%, which is well above the historical long-term real return of comparable bonds[8].

TIPS offer investors an option for portfolio diversification that no other instrument can replicate. Thus far, TIPS alone have not presented a good opportunity for extraordinary returns, nor do they eliminate risk over the long run. However, as part of a diversified portfolio, their higher correlation with inflation and low correlation with other assets offer great diversification benefits for traditional stock, bond and cash portfolios. For investors with most of their portfolios invested in traditional financial assets, the inclusion of TIPS reduces the risk and increases the return of the entire portfolio. This study has shown that portfolios including TIPS offer better performance than portfolios that neglect them.

[8] The average annual real return on U.S. long-term government bond is 2.5% from 1926-1998 as reported in *Stocks, Bonds, Bills, and Inflation 1999 Yearbook*, Ibbotson Associates, Chicago, IL.

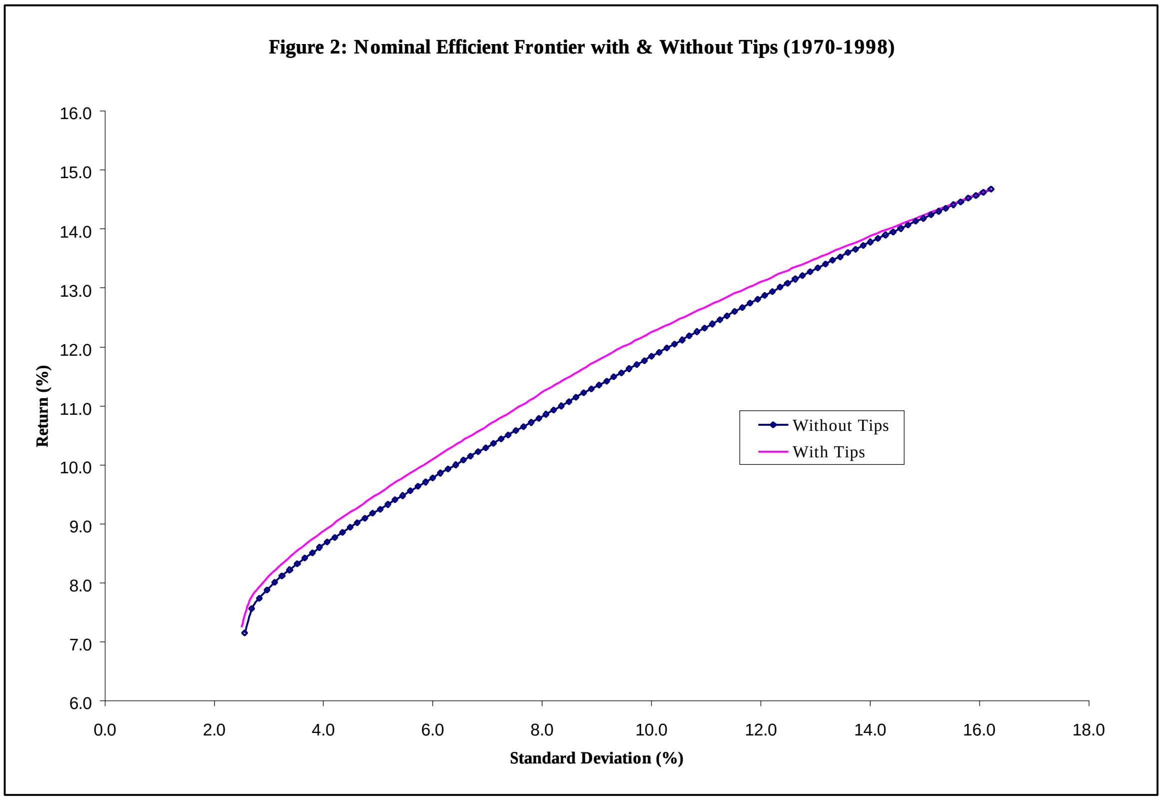


Figure 2: Nominal Efficient Frontier with & Without Tips (1970-1998)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
Return (%)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
Standard Deviation (%)
Without Tips
With Tips

**Figure 3: Nominal Efficient Allocations without Tips(1970-1998)**

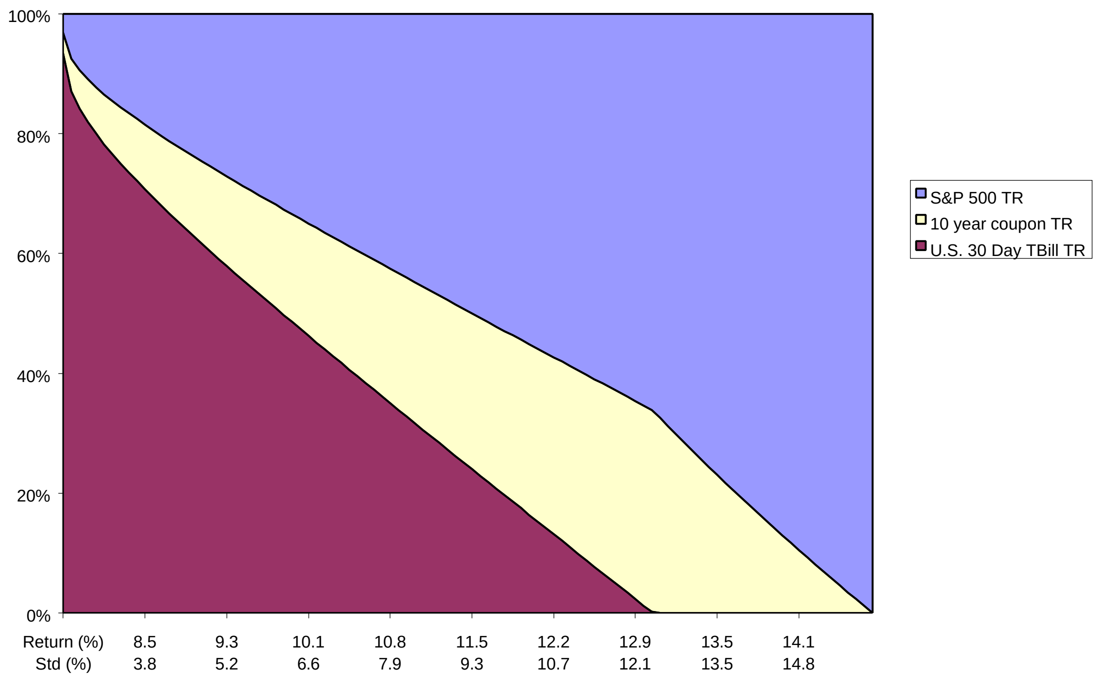
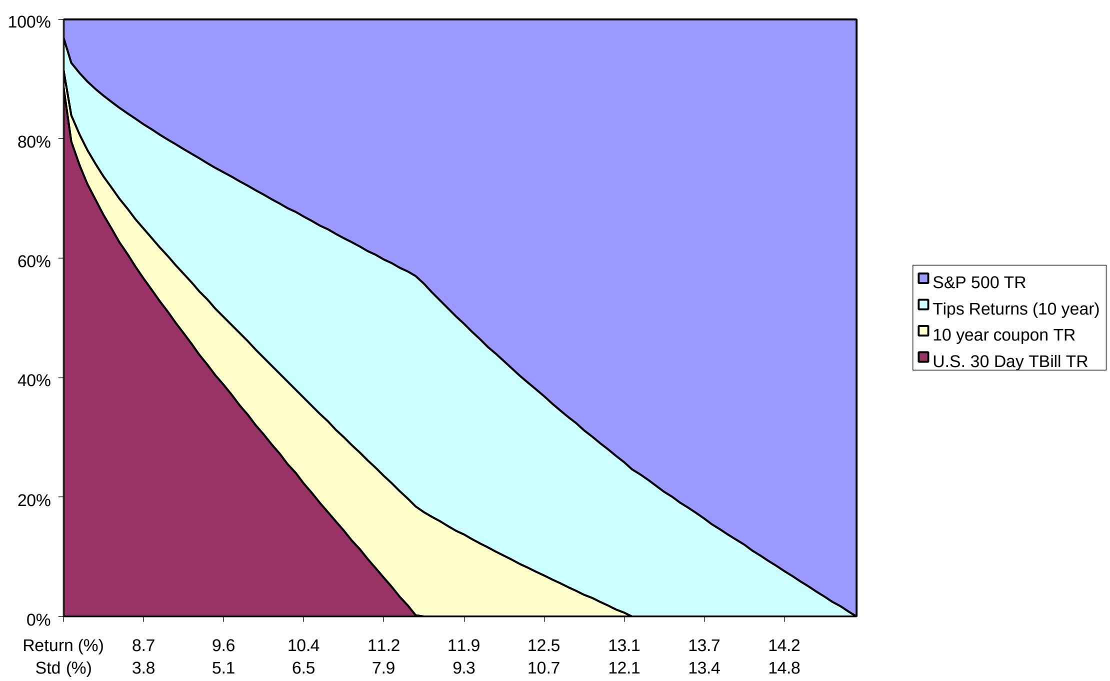



**Figure 4: Nominal Efficient Allocations With Tips (1970-1998)**



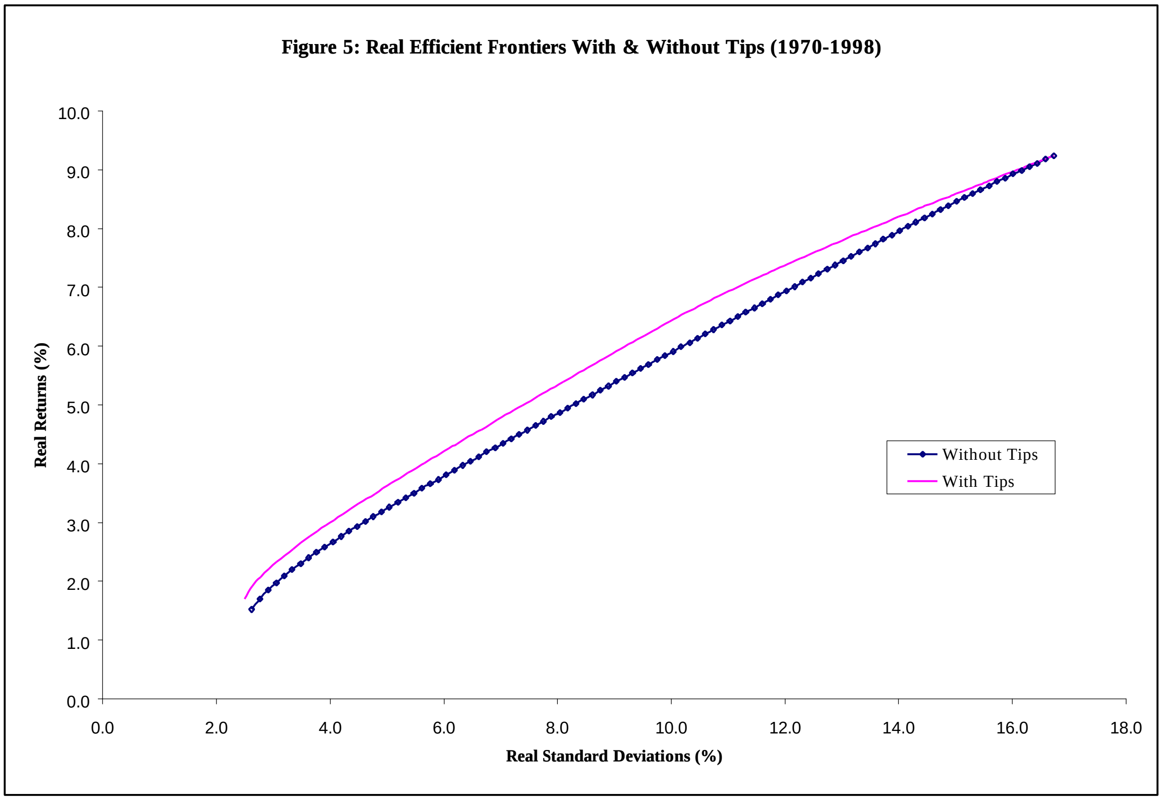


Figure 5: Real Efficient Frontiers With & Without Tips (1970-1998)
Real Returns (%)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
Real Standard Deviations (%)
Without Tips
With Tips

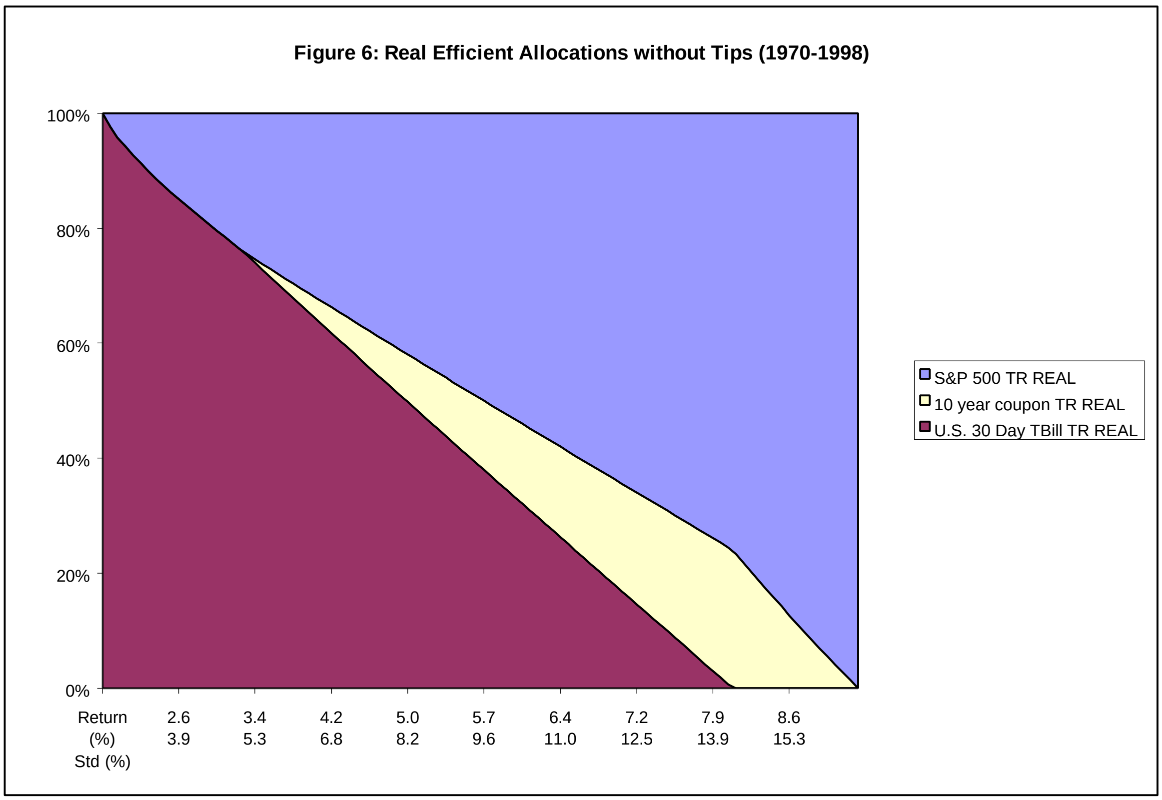
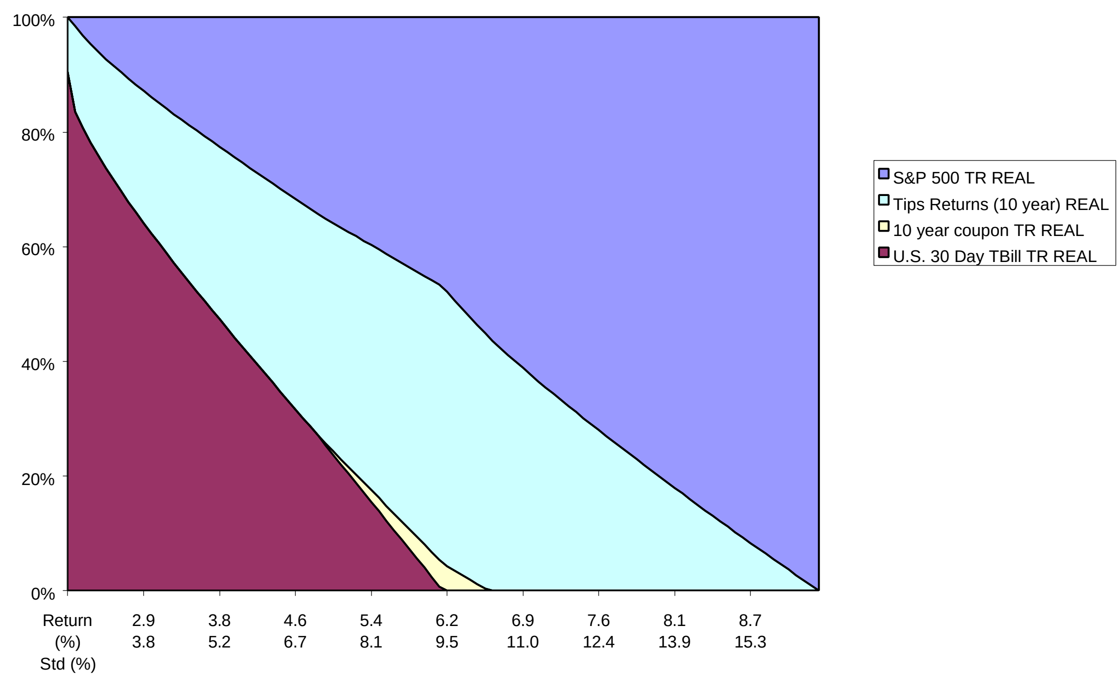


Figure 6: Real Efficient Allocations without Tips (1970-1998)
100%
80%
60%
40%
20%
0%
Return (%)
Std (%)
2.6 3.9
3.4 5.3
4.2 6.8
5.0 8.2
5.7 9.6
6.4 11.0
7.2 12.5
7.9 13.9
8.6 15.3
S&P 500 TR REAL
10 year coupon TR REAL
U.S. 30 Day TBill TR REAL

**Figure 7: Real Efficient Allocations with Tips (1970-1998)**



## Appendix A

### Historical Real Yields

Theoretically, an inflation-linked bond series can be thought of as the price of the *real* yield of a bond (in contrast to regular bonds that price nominal yields). In other words, the price of an inflation-indexed bond is only affected by changes in real yields. When real yields increase, the inflation-indexed bond price will fall; when real yields decrease, the inflation-indexed bond price will rise. Therefore, it is critical to develop a historical real yield series in order to construct the synthetic inflation-indexed bond series.

To estimate historical real yields, we apply the Domestic Fisher Relation. The nominal yield, $r_N$, is the compounding of the real yield, $r_R$, and expected inflation, E(I), over the investment time horizon.

$$r_N = (1 + r_R) \times (1 + E(I)) - 1 \approx r_R + E(I) \quad (1)$$

Therefore, the real yield can be approximated by the nominal yield less expected inflation.

$$r_R = (1 + r_N)/(1 + E(I)) - 1 \approx r_N - E(I) \quad (2)$$

Historical nominal yields are readily available, and can be estimated from the prices of bonds traded in the open market. However, a measurement of expected inflation is not readily available. The authors agree with Lucas and Queck [1998] that "predicting inflation is a difficult job . . . [and] perhaps this is why the market uses YOY CPI as its inflation forecast; it is as good as any other method." As such, in our analysis, we use an adaptive expectations approach, whereby expected inflation is proxied by the most recent calendar year's inflation rate.

Both nominal yields and real yields can be observed from the current market prices for regular Treasury bonds and inflation-indexed bonds. According to the Fisher relation, the implied expected inflation would be the difference between the nominal and real yields. Several alternative models were explored as a proxy for market expected inflation, including: monthly and annual auto-regression, a weighted average of recent inflation and the inflation forecast by the Survey of Professional Forecasters (formerly ASA/NBER Economic Outlook Survey). However, the inflationary expectations formed through these various methods violate the Fisher relation in the current market; the expectations produced are much higher than the implied inflation from the bond yields. If the inflationary expectations from these models are correct, then there is an arbitrage opportunity, where investors should buy inflation-indexed bonds and sell nominal bonds. Since we believe the market is relatively efficient, there should not be such an arbitrage opportunity. Therefore, the inflation models inherent in these various approaches must be inaccurate. We determined to make the simplifying assumption that the inflation process follows a random walk,

$$I_t = I_{t-1} + e$$

and

$$E(I_t) = I_{t-1}$$

Where, $I_t$ is the inflation of period t

ε is a random term with zero mean.

Therefore, the expected real yield on a nominal bond is

$$r_R = r_N - E(I) = r_N - I_{t-1} \quad (3)$$

Investors should be willing to accept a lower real yield for inflation-indexed bonds than nominal bonds, since inflation-indexed bonds provide a perfect inflation hedge. Investors pay a premium for owning inflation-indexed bonds. Intuitively, the real return of an inflation-indexed bond will be lower than the implied real rate of return from a nominal bond, because an inflation-indexed bond guarantees that the return will keep pace with inflation. The current premium is calculated as the difference between the expected real return of the nominal bond and the current real yield of the inflation-indexed bond with a comparable maturity. The following equation expresses this calculation:

$$IIP_t = r_{N,t} - E(I) - r_{II,t} = r_{N,t} - I_{t-1} - r_{II,t} \tag{4}$$

As of 03/05/1999, the nominal yield on a traditional 10-year government bond and the yield on a 10-year inflation-indexed bond were:

$r_N$ = 5.67%
$r_{II}$ = 3.89%

The increase in inflation during calendar year 1998 was:

$I_{t-1}$ = 1.61%

The current inflation-index premium, from (4), above = 5.67% - 1.61% -3.89% = 0.17%

This premium is assumed to be proportional to the past 36 months standard deviation of inflation. The idea is that the premium investors are willing to pay is tied to the recent volatility of inflation. If the inflation volatility is high, then investors are willing to pay a higher premium. The historical inflation index premium can be derived as follows:

$$IIP_i = \frac{S_i}{S_t} \times IIP_t \tag{5}$$

Where, i is any month in the past (since January 1970)

$S_t$ is the standard deviation of inflation over the 36 month time period from Feb. 1996 through Jan. 1999

$S_i$ is the standard deviation of inflation over the most recent 36 month time period from month i

Finally, subtracting the inflation index premium from the real yield produces a synthetic measurement of historical yields for inflation-indexed bonds.

$$r_{II,t} = r_{R,t} - IIP_t = r_N - E(I) - IIP_t = r_N - I_{t-1} - IIP_t \tag{6}$$

Several assumptions were made in the use of the above method:

1. The availability (i.e. presence or absence) of inflation-indexed bonds in the marketplace has no impact on the inflation rate or the market prices of bonds.
2. Expected inflation is assumed to be the most recent twelve months' inflation rate.
3. A nominal bond's expected real rate of return is equal to the difference between the bond's yield and expected inflation. The expected real interest rate will always be greater than two percent.

## Historical Return Series

The objective of the analysis was to create a synthetic inflation-indexed bond series having a maturity of ten years, as well as a series having a maturity equivalent to the assumed investment time horizon of twenty years. We calculate the total returns by utilizing the historical yields (derived via the methodology described above) of the inflation-indexed bonds. It is assumed that the manager of the portfolio buys a newly issued par bond at the beginning of each month, and then sells it at the beginning of the next month. We calculated the rate of return for the synthetic inflation-indexed bonds for each month from January 1970 through December 1998.

The income and total returns are calculated through the following formulas:

$$TR = \frac{\left[\dfrac{redemption}{\left(1+\dfrac{yld}{frequency}\right)^{N-1+\frac{DSC}{E}}}\right]+\left[\displaystyle\sum_{k=1}^{N}\dfrac{100\times\dfrac{rate}{frequency}}{\left(1+\dfrac{yld}{frequency}\right)^{N-1+\frac{DSC}{E}}}\right]}{par}\times(1+I)-1$$

$$IR = \frac{rate}{frequency}\times\frac{A}{E}$$

Where, TR = Total return

IR = Income Return

DSC = number of days from settlement day to the next coupon date.

E = number of days in coupon period in which settlement date occurs.

N = number of coupons payable between settlement date and redemption date.

A = number of days from beginning of coupon period to settlement date.

Rate = annual coupon rate (yield when the inflation-indexed bond was bought)

Frequency = frequency of coupon payments per year

Yld = yield to maturity (the current yield on the inflation-indexed bond)

I = inflation over the most recent calendar year

Par = original face value of a bond

Redemption = proceeds from the sale of a bond

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