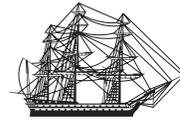


# Investing in Treasury Inflation Protected Securities

Vanguard Investment Counseling & Research



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## Executive Summary

Inflation-protected securities are bonds with unique investment characteristics. These securities represent a relatively new type of financial asset in the United States, where the government first issued Treasury Inflation-Indexed Securities (also called Treasury inflation-protected securities, or TIPS) in January 1997. The TIPS market has experienced rapid growth: Its total value had climbed from \$31.06 billion, or 1.45% of the conventional U.S. Treasury market, at the end of 1997 to \$305 billion, or 13.5% of that market, by the end of 2005. In countries with a longer issuance history, such as the United Kingdom, inflation-indexed bonds currently account for approximately 40% of outstanding government debt. The Treasury Department reaffirmed its commitment to TIPS and announced that it planned to add additional maturities to TIPS' issuance cycle. Vanguard expects the TIPS market to continue to grow in importance.

Understanding the mechanics of TIPS and how their performance may differ from that of other financial assets in varying market environments is the first step in deciding whether and how to include these securities in an investment portfolio. TIPS make sense for many investors, as their characteristics offer some advantages over those of conventional Treasury bonds.

## Why inflation-protected securities?

Investors in traditional fixed income securities have historically concerned themselves with two broad types of risk: credit risk and nominal interest rate risk. Investors can manage credit risk—the risk of price declines due to issuers’ credit troubles—by diversifying and by deciding how much, if any, portfolio exposure to take beyond “risk-free” U.S. Treasury securities. They can manage nominal interest rate risk—the risk of a decline in the market value of fixed income holdings caused by a higher nominal interest rate—by targeting an average portfolio duration that results in an acceptable level of potential price volatility.

The impact of inflation is an important consideration when evaluating nominal interest rate risk. Investors cannot with certainty manage inflation risk—the risk that the returns earned across the investor’s time horizon fall short of actual inflation—in a portfolio of traditional fixed income securities. A bond portfolio’s “real” (inflation-adjusted) value falls when actual inflation exceeds the “expected rate” of inflation that was built into market interest rates at the time the investor purchased the bond. But with the advent of TIPS, which provide for inflation-adjusted increases in both principal value and interest payments, investors can now manage the extent to which their fixed income portfolios are subject to inflation risk.

## The basic mechanics of TIPS

How do TIPS protect against inflation risk? Like most other longer-term bonds, individual TIPS are issued with a fixed coupon interest rate (e.g., 2.25%) and a fixed maturity date (e.g., January 15, 2012). But unlike

traditional bonds, TIPS have a principal value that changes; it is raised (or lowered) by the Treasury each month to keep pace with inflation. As a result, the semiannual coupon payments to investors also change, because they are derived by applying the fixed coupon rate to an inflation-adjusted principal amount. The inflation adjustment is based on a two-month-lagged value of the non-seasonally adjusted Consumer Price Index for Urban Consumers (CPI-U). TIPS investors, then, are guaranteed protection for the real value of their periodic interest payments, and, at maturity, their invested principal. Table 1 shows a hypothetical illustration of the inflation adjustment.

TIPS also provide some deflation protection to the principal (but not to the coupon payments). At maturity, if consumer prices have fallen so much that the inflation-adjusted principal would be below par, the Treasury will repay the principal at par value. In this manner, TIPS provide a “deflation floor.”

TIPS are taxed in a slightly different manner than conventional Treasury bonds. The periodic inflation-based “gross-up” in the principal of TIPS is taxed at the ordinary income tax rate, rather than at the lower capital gains rate. These taxes are payable every tax year regardless of the investor’s holding period. If the sale price of a TIPS bond exceeds the inflation-adjusted principal, ordinary capital gains tax rates are applied. As with conventional Treasuries, the inflation-adjusted TIPS coupon payments are taxed at ordinary income tax rates.

Despite the surface differences, the tax treatment of TIPS and conventional Treasuries is conceptually the same. The TIPS inflation adjustments to principal and coupon payments are similar to the expected inflation component embedded in the coupon payment of conventional Treasury securities. And, since this component of the conventional Treasury

Table 1. Hypothetical example of inflation adjustment to a TIPS bond

Time Period	Standard coupon	Inflation	Principal	Principal adjustment	Coupon payment		
					Standard portion	Inflation portion	Total payment
Year 1	2%	0%	\$1,000	\$ 0	\$20.00	\$0.00	\$20.00
Year 2	2	3	1,030	30	20.00	0.60	20.60
Year 3	2	4	1,071	41	20.00	1.42	21.42
Year 4	2	5	1,124	53	20.00	2.48	22.48
Year 5	2	-1	1,113	(11)	20.00	2.26	22.26

Source: Vanguard Investment Counseling & Research.

coupon is taxed at ordinary income tax rates, the equivalent component of TIPS' return should be taxed in the same manner.

Both taxable and tax-deferred investors should be aware that TIPS do not eliminate all kinds of inflation risk. Investors face "basis risk"—the difference between inflation as measured by the CPI-U and inflation in the mix of goods and services an investor will actually purchase. For example, TIPS might be used to save for college tuition costs. If increases in college tuition are greater than increases in the CPI-U, the investor will face a real return shortfall.

## Comparing TIPS and conventional Treasury bonds

### Understanding yield differences

To understand the differences in yields between TIPS and conventional bonds, it's useful to review the components of the nominal yields for both.

Treasury Nominal Yield = Real yield + expected inflation rate + inflation risk premium

TIPS Nominal Yield = Real yield + lagged actual inflation rate

For example, an investor who, over a given time period, is: Seeking a real return of 3%, expecting inflation to average 2.5%, and demanding an inflation risk premium of 0.5% would be willing to buy a conventional Treasury yielding 6%. The same investor should also be willing to buy a comparable-maturity TIPS with a coupon yield of 3.00%, because it would provide a 3.00% real return plus an adjustment to match whatever the inflation rate turns out to be.

As you can see, the yields will differ depending on both the size of the inflation risk premium and the gap between expected inflation and lagged actual inflation.

Under most economic and market conditions, expected inflation and lagged actual inflation will not deviate substantially over short time horizons. As a result, the size of the inflation risk premium will be the main factor in the yield differences between conventional Treasury bonds and TIPS. The size of the inflation risk premium depends on the level of investor uncertainty about inflation. A proxy for this uncertainty is the volatility of actual inflation.

Additional factors may affect the relative yields. For example, the lower liquidity of the smaller TIPS market may result in a slight increase in TIPS yields to compensate investors for liquidity risk. In other countries, such as the United Kingdom, this yield premium for liquidity risk was significant at first but has declined over time. In the U.S. market, TIPS liquidity is improving and now approximates the liquidity of the U.S. government agency bond market. As the market continues to develop, liquidity risk is not expected to be a major influence on pricing.

### Understanding differences in total return volatility

TIPS have experienced less volatility in total returns than conventional Treasury bonds, as shown by the standard deviation figures in Table 2. Figure 1 (on page 4) illustrates the historical difference in return volatility for constant-maturity 10-year TIPS and 10-year conventional Treasuries. The lower historical volatility of TIPS can be understood by examining the components of total return.

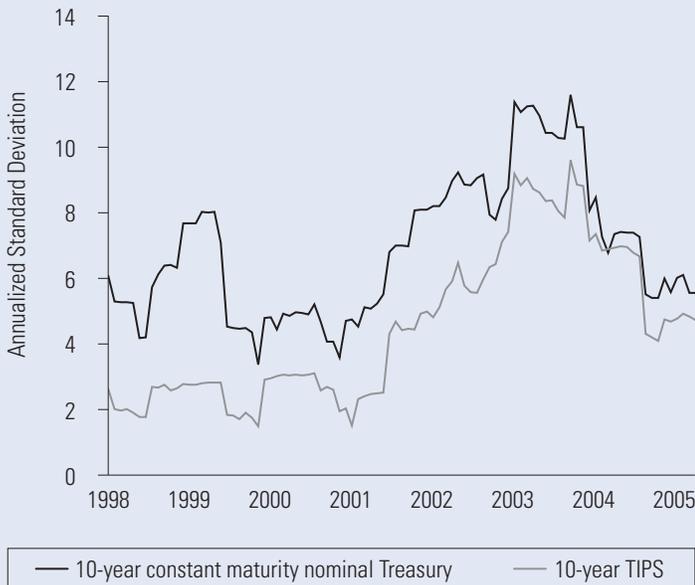
TIPS' total return has both income and price-change components. By price, we mean the quoted market price. Both of these return components are adjusted for inflation. Thus, the volatility of actual inflation can influence that of TIPS returns. Figure 2 (on page 5) illustrates the volatility of inflation as

Table 2. The return and volatility of TIPS and nominal Treasuries

Time period measured	Bond issues	Average monthly total return (%)	Standard deviation (%)	Risk-adjusted return (%)
August 1997– July 2002	5-year nominal Treasury matured June 2002	0.48%	0.66%	0.73%
March 1997– December 2005	5-year TIPS matured July 2002	0.50	0.40	1.25
May 1998– December 2005	10-year constant maturity nominal Treasury bonds	0.59	2.01	0.29
	10-year constant maturity TIPS	0.59	1.40	0.42
	30-year nominal Treasury with maturity date of February 2027	0.68	2.88	0.24
	20-year TIPS with maturity date of April 2028	0.83	2.59	0.32

Source: Vanguard Investment Counseling & Research.

Figure 1. Comparing volatilities between nominal bonds and TIPS



Source: Vanguard Investment Counseling & Research.

measured by the non-seasonally adjusted CPI-U. TIPS returns also are affected by changes in real interest rates: TIPS prices vary inversely with such changes. However, real interest rates are not especially volatile.

The prices of conventional Treasuries vary inversely with changes in nominal interest rates, which consist of real interest rates plus expected inflation and the inflation risk premium. Thus, the prices of conventional Treasuries are affected by three factors, whereas TIPS prices are affected by only two, real interest rates and realized inflation. The additional influence exerted by changes in inflation expectations and in the inflation risk premium is the reason that conventional Treasuries have greater total return volatility than TIPS.

Inflationary expectations and the inflation risk premium are quite volatile. If actual inflation exceeds expected inflation, a negative “inflation surprise” has occurred and prices of conventional Treasuries fall. The possibility of such negative surprises is why investors “demand” an inflation risk premium, which provides protection in case the inflation expectations built into bond yields are wrong. But price declines are especially severe when actual inflation exceeds both expected inflation and the inflation risk premium.

When actual inflation is significantly different from expected inflation (i.e., when investors’ forecasts are especially inaccurate), the total return volatility of

conventional Treasuries will increase. During such periods, the inflation risk premium also increases, further exacerbating the price volatility of conventional Treasuries compared with that of TIPS.

Figure 2 illustrates that actual inflation, as measured by the CPI-U, is quite volatile. The volatility of actual inflation is a fair estimate of the volatility of inflationary expectations, because expected inflation for the market as a whole—although made up of a myriad of individual forecasts—can be assumed to follow a random walk. In other words, the best guess of the next period’s inflation is based on the current period’s inflation rate. The volatility of inflationary expectations is an important factor causing conventional Treasuries to have greater volatility than TIPS.

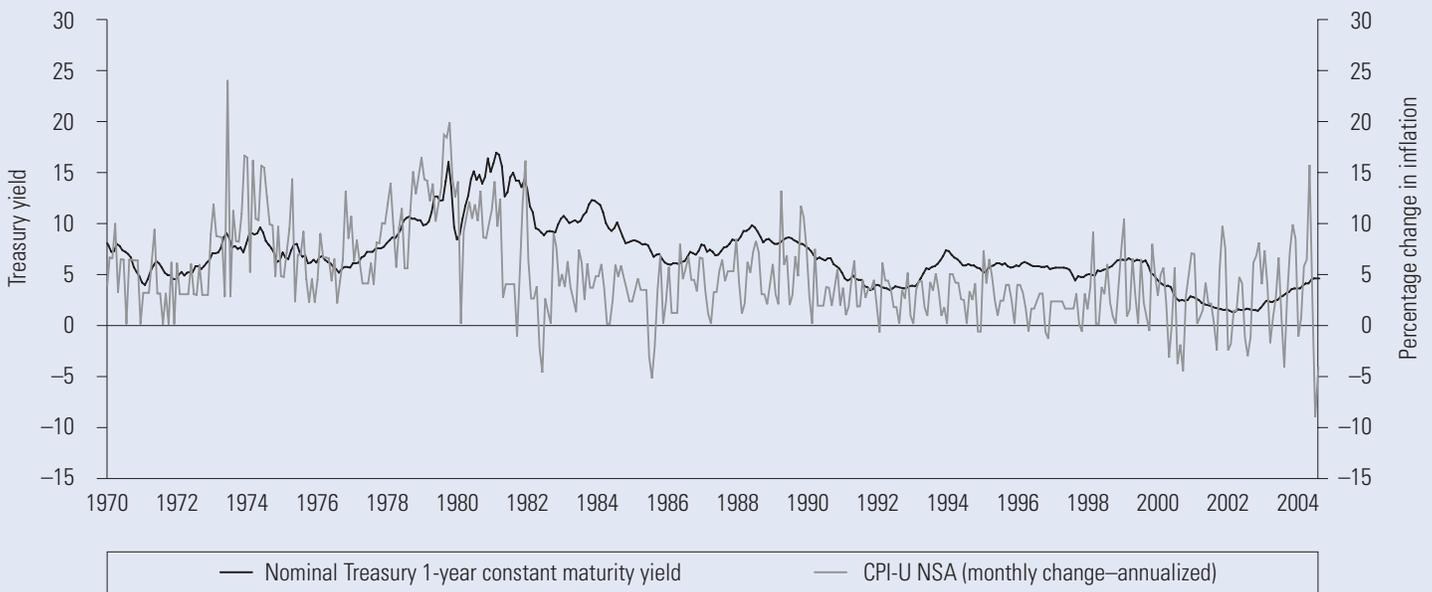
### How do TIPS perform in different economic environments?

Differences in performance (total returns) of TIPS and conventional Treasuries depend largely on inflation surprises and changes in inflationary expectations. Figure 2 shows that, even over short horizons, surprises occur in which actual inflation is above or below the inflationary expectation covered by nominal yield. So, over long horizons, inflation surprises are quite common. The Federal Reserve Board’s monetary policy response to inflation surprises and changes in inflationary expectations adds complication to the analysis. To form a conceptual framework, a definition of “breakeven inflation” is a good place to start.

Breakeven inflation is the difference in the nominal yield of a conventional Treasury bond and the real yield of a similar-maturity TIPS bond: Breakeven Inflation = expected inflation rate + inflation risk premium.

Over the lives of the bonds, when actual inflation exceeds breakeven inflation, a negative inflation surprise has occurred and the TIPS bond would provide superior returns to a similar-maturity conventional Treasury. Conversely, when actual inflation is less than breakeven inflation, a positive surprise has occurred and the conventional Treasury will provide superior returns. In such cases, the inflation risk premium gives an added boost to conventional Treasury returns since it turns out that the premium provided unneeded protection against inflation uncertainty. Figure 3 (on page 6) depicts breakeven inflation, based on TIPS with 10-year constant maturity. This is the level of inflation the market

Figure 2. Actual year-over-year inflation versus expected inflation represented by the 1-year nominal Treasury yield



Source: Vanguard Investment Counseling & Research.

anticipates over the next 10 years for the yields of nominal and inflation-protected bonds to be equivalent. For example, as of December 31, 2005, the market had built in an anticipated annualized inflation rate of 2.3%. If the actual annualized inflation rate over the 10 years ended December 31, 2015, is different from 2.3%, an unexpected inflation shock would have occurred.

The bond market isn't alone in responding to inflation surprises. The Federal Reserve Board reacts too. If a negative surprise (higher-than-expected inflation) occurs, the Fed is likely to tighten monetary policy, raising nominal interest rates so that economic activity cools and inflation does not get out of hand. If a positive surprise has occurred, the Fed may lower nominal interest rates to prevent future slowing in the economy. (Specific policy reactions will depend upon which phase of the business cycle dominates the economy at a given point.) Next, we describe the dynamics at work in three scenarios: a period with a negative inflation surprise; a period with no surprises; and a period with a positive inflation surprise.

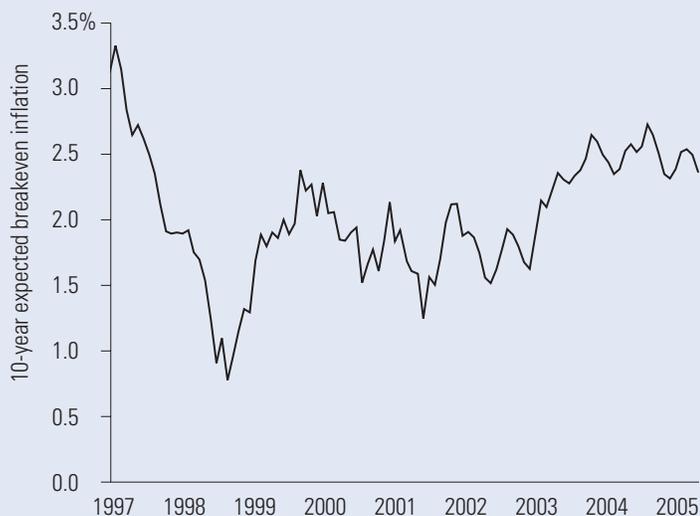
#### Negative inflation surprises

A negative inflation surprise means that actual inflation was greater than expected. As a result, the inflation risk premium previously priced into the conventional bond turned out to be insufficient.

Negative surprises hurt conventional Treasuries and benefit TIPS, causing TIPS to perform better and reducing correlations of returns for the two types of bonds. Movements in real interest rates may mitigate the change in correlations. A negative

Deflation—an actual fall in consumer prices—is a TIPS investor's nightmare scenario. Nominal Treasury bonds would rise in value as market yields declined in response to deflation. Although deflation likely would reduce real interest rates as well, this effect would probably be more than offset by the downward inflation adjustment to TIPS' principal. The result could be a fall in the market price of TIPS. Accrued increases in principal due to prior inflation would, to a point, be offset: For example, a \$100,000 par TIPS whose principal value had risen to \$105,062 after two years of 2.5% inflation would, after a year's deflation of 2.5%, decline to \$102,435. Interest payments would fall too: Given a coupon of, say, 2.27%, annual payments would shrink from \$2,385 to \$2,325. If deflation continued, income would keep falling as the deflation-indexed principal value was adjusted lower. The only good news in such a scenario is that, in theory, the TIPS investor would be no worse off, since the "real" value of principal and income would be unchanged.

Figure 3. The 10-year expected breakeven inflation rate



Source: Vanguard Investment Counseling & Research.

inflation shock often prompts the Fed to tighten the money supply by substantially raising short-term real rates. If inflation subsequently subsides, real rates may fall, possibly ushering in a period of positive inflation surprises. The movement in real rates may overwhelm the change in correlation that occurred in the wake of the negative inflation surprise.

#### No inflation surprises

In periods when actual inflation is close to inflation expectations, the total returns of TIPS and conventional Treasuries will be closely correlated. The performance of both types of bonds will be driven by changes in real interest rates. Variations in their performance relative to each other will depend upon the level and volatility of inflation.

#### Positive inflation surprises

A positive inflation surprise means that actual inflation was lower than expected inflation. As a result, the inflation risk premium that had been priced into the conventional bond turned out to be excessive. The prices of conventional bonds rise as inflation expectations decline and result in lower nominal rates. If inflation, though lower than expected, is still positive, the TIPS price will rise by the inflation adjustment. However, the inflation adjustment to TIPS prices will

be less than the expected inflation component of the conventional Treasury's yield. In such cases, the prices of both bonds will rise and the correlation between returns for TIPS and conventional Treasuries will increase. A positive inflation shock often prompts the Fed to loosen the money supply by lowering short-term real interest rates. Declining real interest rates boost returns for both types of bonds, but positive inflation surprises generally benefit conventional Treasuries more than TIPS.

Given the limited history of TIPS in the United States, the analysis above is a useful framework for thinking about how TIPS might perform in different economic environments. Another useful exercise is to examine other markets in which inflation-indexed bonds have a longer history. We believe the experience in the United Kingdom, where inflation-indexed bonds have more than 20 years of history, is particularly relevant. An analysis of the U.K. experience shows that the relative performance of TIPS and conventional government bonds depends upon both how future actual inflation compares with inflation expectations and how monetary policy is changed in response to economic conditions.

Analyzing both the U.S. experience and the longer U.K. history with inflation-indexed bonds, we summarize in Table 3 (on page 7) how TIPS are expected to perform relative to conventional Treasuries given possible inflation surprises and the associated monetary policy response.

#### Who should invest in TIPS

TIPS are appropriate to fund a spending program when principal and purchasing power, in real terms, need to be preserved with a high degree of certainty. Some analysts also propose that investors can potentially enhance diversification and return by substituting TIPS for conventional Treasuries and increasing the portfolio weighting in equities. Correlation analysis, based on the short U.S. TIPS market history, supports this view, given that TIPS so far have had lower correlations with equities than conventional Treasuries have had. However, an analysis of the U.K. market suggests that significant differences in correlation are not likely to persist. In the United Kingdom, correlations between U.K. equities and index-linked gilts (ILGs, the British equivalent to TIPS) and between equities and conventional gilts have been approximately equal.

Table 3. Performance of TIPS and conventional Treasuries in various scenarios

Inflation scenarios	Possible policy stances for the Federal Reserve		
	Lower fed funds rate (Easing of monetary policy)	No rate change	Raise fed funds rate (Tightening of monetary policy)
Positive inflation surprise	<ul style="list-style-type: none"> <li>The likelihood of the Fed easing monetary policy rises with the magnitude of the surprise.</li> </ul>	<ul style="list-style-type: none"> <li>The Fed may not react if the surprise is mild and seen as temporary.</li> </ul>	<ul style="list-style-type: none"> <li>The Fed is unlikely to tighten when inflation is lower than expected.</li> </ul>
	<ul style="list-style-type: none"> <li>Total return of conventional bonds should outpace return of TIPS.</li> </ul>	<ul style="list-style-type: none"> <li>Total return of conventional bonds should outpace return of TIPS.</li> </ul>	<ul style="list-style-type: none"> <li>Total return of conventional bonds should outpace return of TIPS.</li> </ul>
	<ul style="list-style-type: none"> <li>High correlation in returns of TIPS and conventional bonds.</li> </ul>	<ul style="list-style-type: none"> <li>High correlation in returns of TIPS and conventional bonds.</li> </ul>	<ul style="list-style-type: none"> <li>High correlation in returns of TIPS and conventional bonds.</li> </ul>
No inflation surprise	<ul style="list-style-type: none"> <li>The Fed is unlikely to ease policy.</li> </ul>	<ul style="list-style-type: none"> <li>The most likely outcome.</li> </ul>	<ul style="list-style-type: none"> <li>The Fed is unlikely to tighten policy.</li> </ul>
	<ul style="list-style-type: none"> <li>The relative performance of conventional bonds and TIPS bonds remains fairly constant.</li> </ul>	<ul style="list-style-type: none"> <li>The relative performance of conventional bonds and TIPS bonds remains fairly constant.</li> </ul>	<ul style="list-style-type: none"> <li>The relative performance of conventional bonds and TIPS bonds remains fairly constant.</li> </ul>
	<ul style="list-style-type: none"> <li>It's hard to predict how correlations would change, given the lag in inflation adjustment.</li> </ul>	<ul style="list-style-type: none"> <li>It's hard to predict how correlations would change, given the lag in inflation adjustment.</li> </ul>	<ul style="list-style-type: none"> <li>It's hard to predict how correlations would change, given the lag in inflation adjustment.</li> </ul>
Negative inflation surprise	<ul style="list-style-type: none"> <li>The Fed is unlikely to ease policy if inflation is higher than expected.</li> </ul>	<ul style="list-style-type: none"> <li>The Fed may not react if the surprise is mild and seen as temporary.</li> </ul>	<ul style="list-style-type: none"> <li>The likelihood of the Fed tightening monetary policy rises with the magnitude of the surprise.</li> </ul>
	<ul style="list-style-type: none"> <li>Conventional bonds will perform worse than TIPS.</li> </ul>	<ul style="list-style-type: none"> <li>Conventional bonds will perform worse than TIPS.</li> </ul>	<ul style="list-style-type: none"> <li>Conventional bonds will perform worse than TIPS.</li> </ul>
	<ul style="list-style-type: none"> <li>The correlation of returns will be lower in the near term, but will rise as interest rates fall.</li> </ul>	<ul style="list-style-type: none"> <li>The correlation of returns will be lower in the near term, but will rise over time.</li> </ul>	<ul style="list-style-type: none"> <li>The correlation of returns will be lower in the near term, but will rise after the rate hike takes hold.</li> </ul>

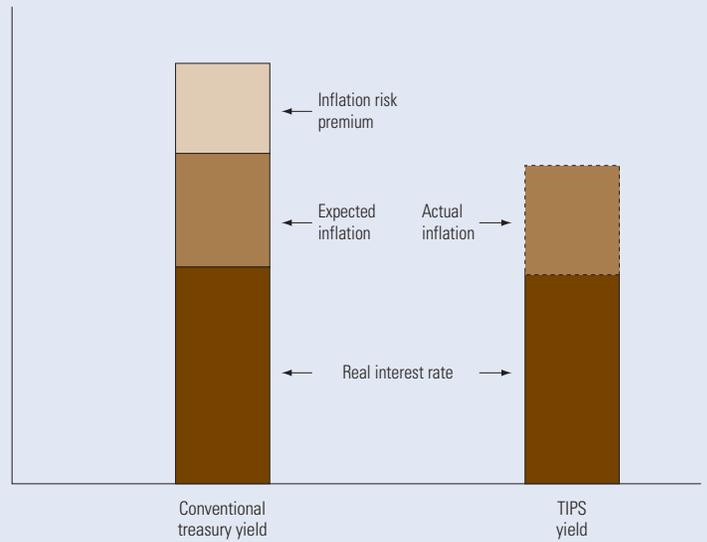
Source: Vanguard Investment Counseling & Research.

It's also useful to bear in mind that the U.S. Treasury was motivated to issue TIPS as a way to reduce long-term debt-servicing costs by assuming inflation risk. Long-term costs are reduced only if monetary policy is credible. And a credible policy (one effective in preventing high inflation) reduces both the inflation risk premium and expected inflation, making changes in real interest rates the dominant factor in changes in yields of both types of bonds. Figures 4a and 4b characterize the goal and its potential effect on yields.

Over the last few years, the U.S. experienced a period of relatively low, stable inflation. In such a climate, changes in prices of conventional Treasury bonds would be attributable mostly to changes in real interest rates. The two types of Treasury securities are likely to experience similar price variability and similar correlations with the stock market. A period of low, stable inflation is also likely to narrow the relative performance of the two types of bonds so that returns will be similar for both nominal and inflation-indexed Treasuries. The 1998–2001 U.K. market experience provides empirical support for this view. Compared with earlier periods when monetary policy was less credible, average returns and volatility during this period were closer, and correlations with equity returns averaged 0.5 for both types of bonds.

Although this analysis questions the conventional wisdom that TIPS will have lower future correlations

Figure 4b. Yields with credible monetary policy



Source: Vanguard Investment Counseling & Research.

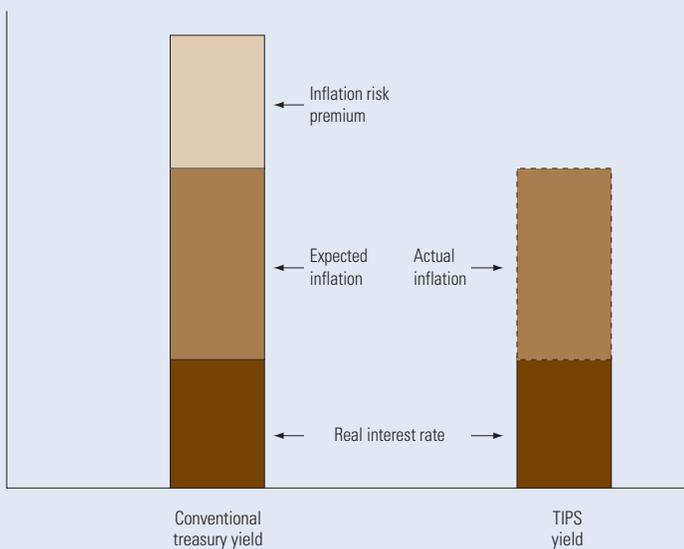
with equities, we do believe that TIPS are likely to provide a better risk-adjusted return than conventional Treasuries (see Figure 1 on page 4) and are well-suited for matching real assets and liabilities.

#### How to invest in TIPS

Investors interested in adding TIPS to their portfolios have two choices: buying individual TIPS issues directly or owning the securities through a mutual fund. For a buy-and-hold investor, the advantage of purchasing TIPS directly is the ability to lock in a known real rate of return and a final maturity date. Also, an investor with large resources can construct a laddered maturity investment program across the “real” interest rate curve. However, owning TIPS directly poses problems for taxable investors, given the mismatch between when adjustments to principal are taxed (current year) and when they are paid (at maturity). Reinvesting the semiannual coupon payments in similar securities is also problematic for the investor who holds TIPS directly. And, as with any security, managers of larger investment pools generally pay lower transaction costs than do investors buying smaller amounts of bonds.

While mutual funds cannot eliminate risk, owning TIPS within a low-cost mutual fund provides the advantage of owning a portfolio of securities across a range of maturities. An open-end, actively managed

Figure 4a. Yields without credible monetary policy



Source: Vanguard Investment Counseling & Research.

TIPS fund probably will be investing new money in TIPS at many points in time, effectively balancing out periods of relative pricing “richness” or “cheapness” across different market cycles. A mutual fund often makes more frequent distributions of accrued income and principal to investors, smoothing their cash flows. In addition, mutual funds are required to distribute all their income, which for TIPS funds includes both the coupon and the inflation adjustment. This means that investors receive both forms of payment within the same tax year.

A mutual fund makes it possible for investors to preserve the full purchasing power of assets committed to a TIPS investment program by providing for the automatic reinvestment of distributions. And, in the event that some or all of a TIPS position needs to be reallocated or spent, a mutual fund offers ready liquidity. Because of this greater flexibility and consistent participation in the benefits of investing in TIPS, a fund holding such securities is likely to be the better choice for most investors than owning individual securities.







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With TIPS, as with any other securities, investors should remember that past performance is not a guarantee of future returns.

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